LAN technology transfer using the Naval Postgraduate School as a case study

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THESIS

LAN TECHNOLOGY TRANSFER USING THE NAVAL POSTGRADUATE SCHOOL AS A CASE STUDY

by

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In today's Department of Defense (DoD) environment, more emphasis is being placed on using computing resources to receive and process information. Local area networks (LANs) are used to access these computing resources by users. As new resources are added to networks, an effective mechanism is required to transfer this technology to the users. The effective transfer of technology requires user awareness of the technology and the ability of the user to use the technology.

This thesis investigates the transfer of technology to users. A case study of the Naval Postgraduate School's Systems Management computer laboratories is the focus of this research. The research describes the typical user's experience level, the network support staff's responsibilities, and the network's hardware and software capabilities. Commercial computer documentation is studied to identify the various methods and media available to support users.

The goal of an organization is to achieve the optimum utilization of resources. This thesis provides a strategy to optimize the utilization of network resources by establishing network performance criteria, supplementing user documentation with a comprehensive resource guide, and improving the communication flow between the users and the support staff. The implementation of this strategy will not only maximize the transfer of technology to the users, but also provide the optimum use of the resources available.

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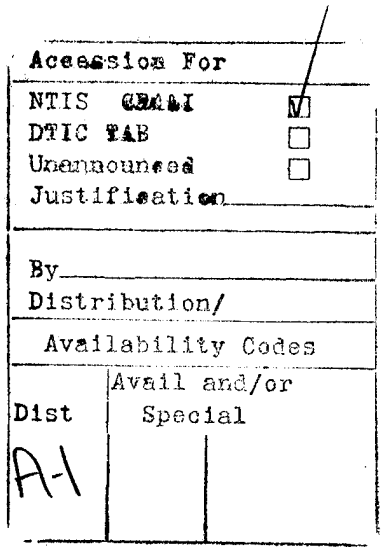

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I. INTRODUCTION

The new information revolution has changed the way America does business. In industry and the Department of Defense (DoD), the demand for fast, accurate, easily accessible information has created a very competitive world in which technology is constantly upgrading to faster and more capable hardware and software. A major component of this technology is the local area network (LAN). The LAN which originally only linked local office equipment has changed with the advancement of technology. Today's LANs have grown more sophisticated and complex with each successive generation developed. Both the hardware and software are requiring the network to provide increased capacity and greater capabilities than was required of the earlier networks. The advantages of these newer networks are increased benefits to the users.

A. BACKGROUND

As networks are upgraded to support new applications and additional resources, these improvements often go unnoticed by the network users. How does one inform current and potential LAN users of the capabilities and resources in such a dynamic environment? To allow the maximum use of the LAN's resources, a mechanism is needed to transfer the technical capabilities of the LANs to the potential users. This mechanism should address the variety of needs and skill levels of the various users.

This thesis analyzes the Systems Management LANs and computing resources located within the department's computer laboratories at the Naval Postgraduate School. After studying the LAN environment, a means will be determined to transfer the knowledge and value of these LAN resources to potential users which include the faculty and students of the Systems Management Department.

B. OBJECTIVES

The primary objective of the study is to produce a mechanism that will increase the faculty and student awareness of the LAN capabilities and resources available in the Systems Management Department. This increased awareness should lead to more productive use of

the department's computing resources. User documentation will be provided which will provide varying levels of information which will include an executive level overview, a basic user resource guide, and a technical reference. This documentation addresses two of the computing laboratories with the anticipation of adding additional documentation as the lab resources change over time.

C. THE RESEARCH QUESTION

What mechanisms are available which will increase the valuation and knowledge of the LAN resources to the faculty and students in the Systems Management (SM) Department and facilitate users in obtaining the maximum use of these facilities?

In order to answer the primary question, other preliminary questions must be considered. These questions are:

- What are the benefits of the existing LAN technology to the department's faculty and students?
- What are the technical requirements for the effective and efficient operation of LANs and what does this cost in terms of personnel and time?
- What resources are available to the LAN administrator to support his duties in maintaining the LAN?
- What hardware and software issues are relevant to the LAN administrator?
- How are upgrades evaluated, implemented, and provided to the LAN's users?
- What technical skill levels are required for the users to successfully use the LAN resources?
- What issues must be addressed to facilitate technology transfer to users?

D. SCOPE

Understanding the complexities and problems associated with LAN technology are the focus of the analysis. By understanding the technology, documentation will be produced for two of the three computer laboratories. This documentation will allow users with various skill levels to optimize their time and productivity while in the lab. A plan for transferring the value of the LAN technology to the faculty and students will be developed to further increase the use of the resources.

E. METHODOLOGY

This paper involves two different, but related areas of study. The first area involves understanding the current LAN technology used in the SM computer labs. The second area of focus is understanding the methods used to effectively transfer technology using training or other resources.

Understanding the current LAN technology requires a technical knowledge of the networks and how the networks are used to interface with the hardware and software resources in the labs. The complexities of the networks are better understood by studying the duties of the network administer as he performs his duties. Both the network and the network administrator's duties were analyzed in the SM labs to provide a better understanding of the LAN environment.

The understanding of technology transfer to users provides the focus of the second area of study. In this context, technology transfer refers to the ability to provide users and potential users with an awareness of the resources available and a means to allow them to effectively use these resources despite their skill or experience levels. Although a great deal of information is available on producing user documentation, less information is available on assessing user skill level.

F. ORGANIZATION OF RESEARCH

The first chapter is the introductory chapter which includes sections that present the problem background, the objectives, the research question, the scope, the research methodology, and a description of the organization of the research.

Chapter II analyzes the technical aspects of the local area networks in this case study. The areas of interest include the hardware, software, topology, and configurations. The configuration analysis looks at both the physical and logical aspects of the network. It relates the capabilities and limitations to these differences.

The network administrator's role is covered in Chapter III. By understanding the duties of a network administrator, a greater appreciation is gained for the complexity and problems that can accompany a LAN. Network management issues that a LAN administrator must address, involve configuration, performance, security, and fault management. Specific examples of problems in these areas are identified in this case study and are discussed. Solutions are provided to the problems if they are available.

User considerations are examined in Chapter IV. User skill levels and experience are discussed with specific attention given to the basic skills required for the operation. Basic tasks are reviewed and user responsibilities are discussed.

Chapter V addresses the issue of technology transfer. The issues that affect user productivity are discussed. The methods and resources available to the staff and the methods most appropriate for use in the computer labs are provided.

The last chapter, Chapter VI, provides the recommendations for implementing the computer lab user's manual (Appendix B). The conclusion discusses the various factors that are required for improving the technology transfer to users.

II. NETWORK OVERVIEW

This chapter provides a brief overview of the networks located in Ingersoll Hall that are managed by the SM Department. The hardware, software, network configuration, and the labs that the networks support are discussed. Each network is identified with a two-part designation. The prefix is a one digit number which is the last digit of the room number and the suffix is the type of network. For example, a token ring in room 224 is designated by 4TR and a Ethernet is designated by 4EN. A similar alphanumeric scheme is used to identify individual computers within the labs. For example, computer number 36 on a token ring is TN36 or computer number 1 on the Ethernet is ENET1. The figures that depict the lab layouts use this labeling scheme for identifying the networks and computers on a network.

A. TOKEN RING

1. Hardware And Topology

The token ring network is the largest network in the SM labs. This network physically connects all three labs in rooms 158, 224, and 250. (See Figures 2.1a & 2.1b.) The token ring protocol, based on the IEEE 802.5 standard, uses managed network access and requires the computers on a network to possess an electronic token before transmitting. This token is passed around the network's logical ring and allows each network computer an opportunity to transmit. Because of the managed access protocol, each computer has an equal opportunity to access the network. This provides a significant speed advantage to the token ring when a large number of users are on the network because there is no time lost resolving the collisions that occur when two computers try to transmit at the same time. Collisions will be discussed in section (B), the section on Ethernet networks.

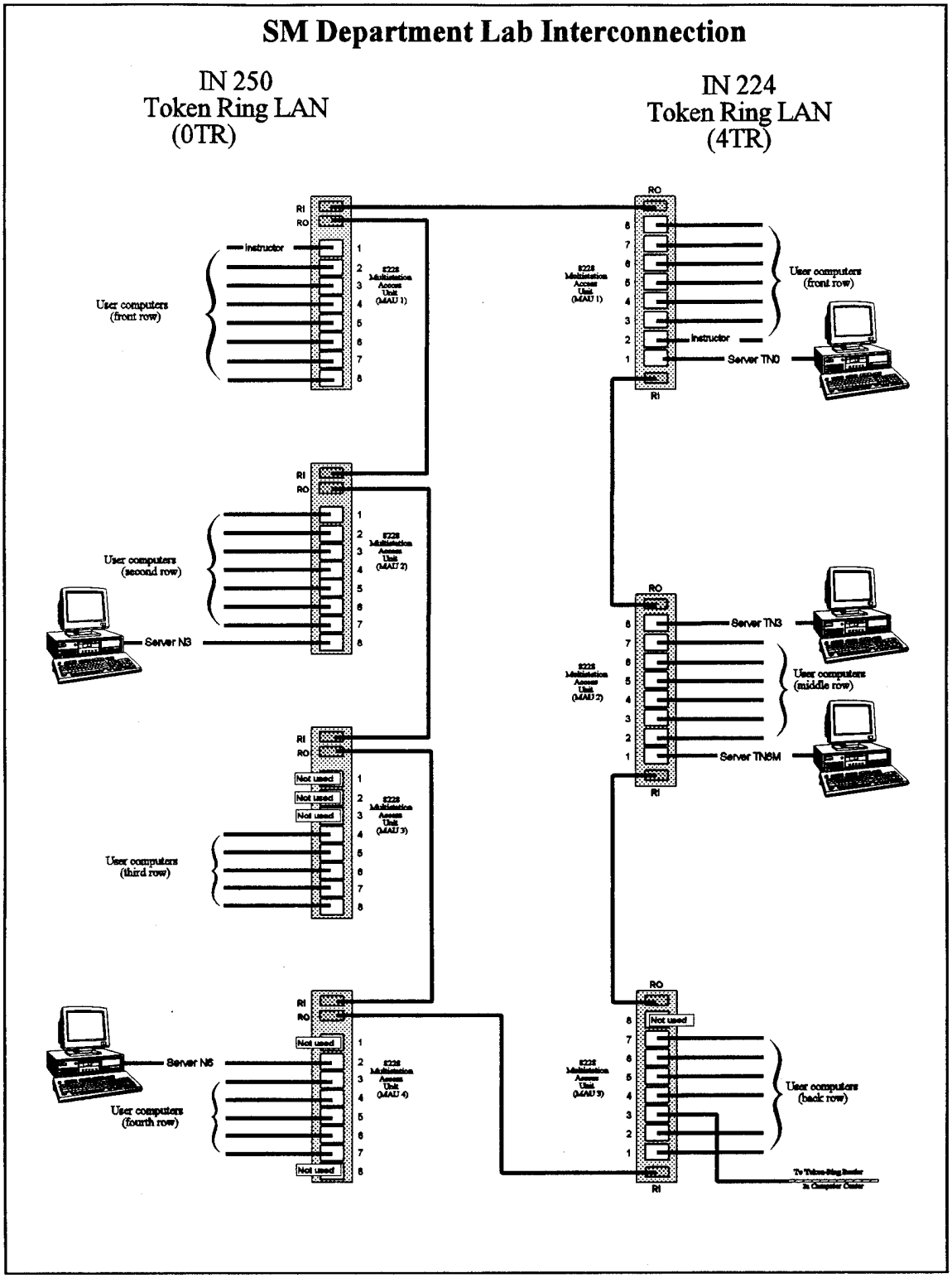

Figure 2.1a Token Ring Lab Connectivity Rooms IN-224 (4TR) And IN-250 (0TR).

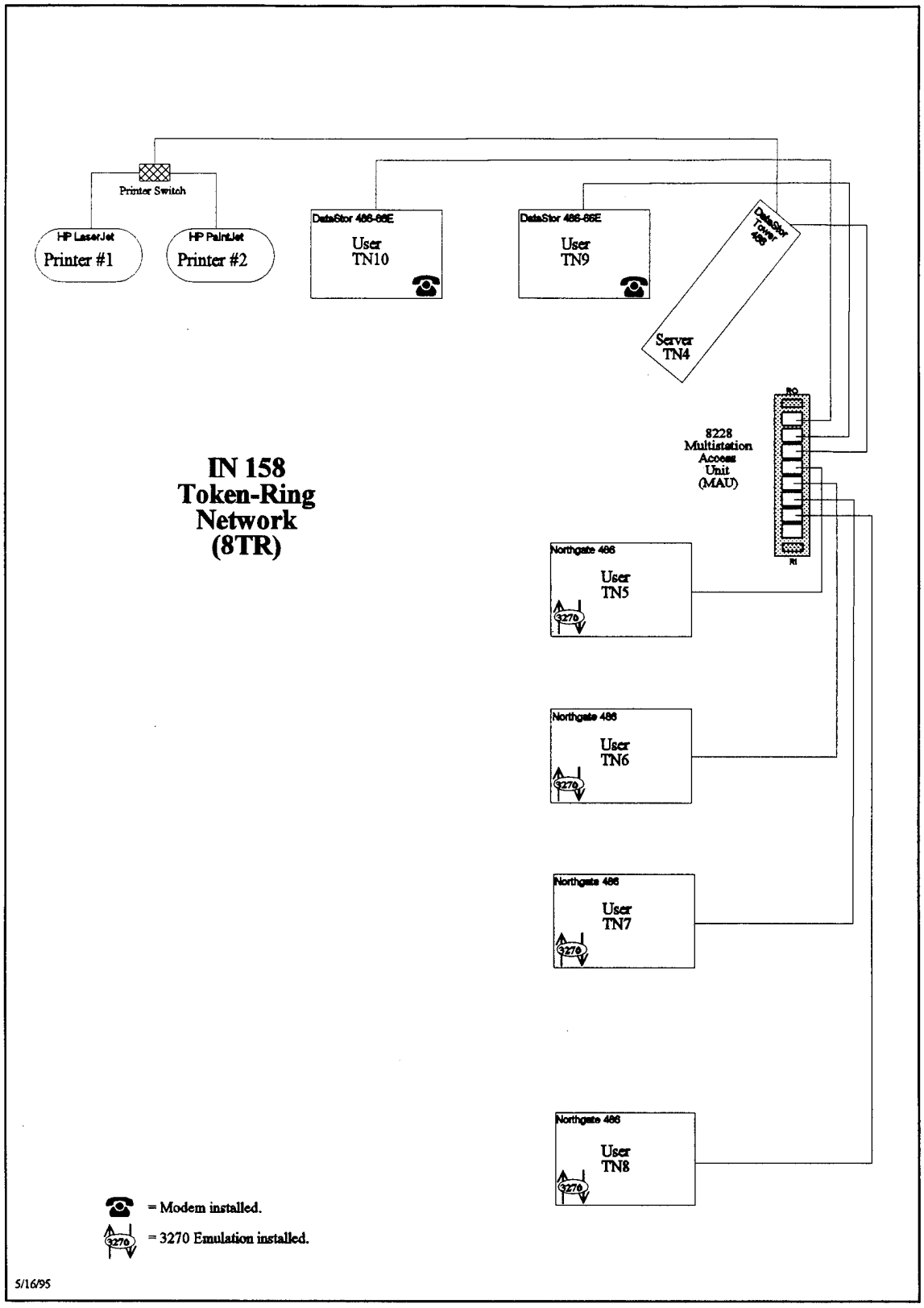

Figure 2.1b Token Ring Room IN-158 (8TR).

The basic hardware components of this network are the IBM compatible personal computers (PCs), the computer network board, the network cables, and the Multistation Access Unit (MAU). PCs have two functions on this network, a server PC and a user/client PC. The servers are dedicated computers which are used on the network to support a special network function. This requires the server computers to be restricted to network use only and not be allowed to be used as a user computer. The server keyboards are kept locked with placards placed on each server to identify it as a server. If the keyboards were allowed to be used, the keyboard inputs would have priority over the server's network functions. This would slow the response time of the network.

Additional hardware may be installed in the various computers to support their functions on the network. For example, a file server may have a larger hard drive or other storage device to accommodate the storage of a large amount of information. All lab computers are configured with eight megabytes of RAM to increase their processing speed. Additional devices may also be included on the user PCs such as modems, CD ROM drives, or scanners. All PCs will have network interface boards installed to allow connection to the network.

The token ring networks in rooms 224 and 250 are each configured with at least one file server in each room to store network programs, utility programs, and user applications. The directories and files on the server's hard drive are configured for read only access. This is achieved through a combination of network operating system (NOS) commands and DOS attribute commands. Network commands allow assigning read, write, or create attributes to the directories. The DOS attribute command can assign read only attributes to files to protect them from changes and alterations by users. The servers have RAM drives that provide improved network performance by avoiding the mechanical delays encountered when searching the hard drives for data. One RAM drive contains the application batch files which are used by the user computers to access applications. A second RAM drive contains network related files that the server requires during network operations. Files are copied to these RAM drives during the server start and remain available in the RAM drive during the server's operation.

The token ring network has a print server available in each room to manage the network's printing functions for that room. In order to print, the print server receives a print request or print job from a user computer and stores the job until the printer is available. When the printer is available to print, the print server then forwards the job to the printer on a first in, first out (FIFO) basis.

The token ring network is a physical star and logical ring network. The physical star is implemented with the Multistation Access Unit (MAU). Each MAU has ten total connections, eight are computer connections, and two are ring in, ring out, connections that allow the MAU to be inserted into the network. The MAU serves as a hub for the various computers along a network and provides bypass circuitry and fault sensing for the network. This provides increased network reliability, and ease of adding (or removing) a computer to the network. Using the ring in and ring out connections, a MAU can extend the number of computers on the network by inserting an additional MAU. These connections also allow the network to span several rooms or floors by using extended length cables.

The media used in this network is "data grade" cable. This cable is composed of shielded, twisted pair wire, with two of the twisted pairs within the shielding. The extra pair provides an additional linkage for backup and the shielding provides improved data flow by minimizing the effect of electromagnetic interference from the local environment. IBM manufactures seven types of cables for use in token ring networks. There are four shielded cables, two unshielded cables, and one optical-fiber cable. (Feibel, pp. 155-156) The cables are used to connect the computer network boards to the MAUs and to connect the MAUs.

There are several other hardware items located in rooms 224 and 250. The lab in room 224 has two dedicated "286" PCs that function as a gateway or link to the mainframe computer. These gateways allow nine of the user PCs in this lab to logon to the mainframe using 3270 emulation.

Internal modems are installed in rooms 224 and 250. These modems use the Simpc program to dial the school's computer center and logon to a mainframe or Unix account at 2400 BPS. The computer center is the only menu item listed in the program because the Simpc program requires Simpc to be used at both ends of the modem connection. The phone

lines are also blocked to allow only local calls on campus. There are six modem equipped PCs in room 224 and seven in room 250.

The CISCO router in the computer center is connected into the MAU in room 224 and allows connectivity to the Campus Backbone when using the TCP/IP protocol. TCP/IP is installed on all computers on the token ring network in rooms 224 and 250.

An AST Graphic Scanner is located in room 224. This scanner is connected to one of the user computers and allows the scanning of graphic images into electronic form. The required scanning software program is installed on the individual PC.

Two external CD ROMs are connected to user computers on the network. One is in room 224 and the other is in room 250. These external CD ROMs allow the reading of optical disks using the software installed locally on the PC. In both rooms, 224 and 250, the CD ROM is designated as the "E" drive on the computer.

Both rooms 224 and 250 have a ceiling mounted video projection system installed. The video input is from the instructor computer located in the front of each lab. This system is useful for class demonstrations and provides excellent visibility to the users seated at their user computers.

2. Software

The network software that is common to all token rings includes the network operating system (NOS), the LAN support programs, the PC's Disk Operating System (DOS), and a memory management program. IBM's PC LAN Program is the NOS used on our token ring network. The kernel of the NOS manages the network and must be resident in the memory of both the server and the user computers for the network to operate. The MS DOS Version 5.0 is the operating system for the PCs and must always be installed before a PC can be used.

The LAN Support Program consists of drivers which provide for the physical and data link layers of the IEEE 802.5 standard. These drivers are at the lower layers of the network architecture and are independent of the type of network.

QEMM is the memory manager used in the PCs in the labs. It provides the memory management that allows the drivers to be successfully loaded and operated within a

computer's limited conventional memory. A complete discussion of this problem is presented in the Fault Management section of Chapter III.

The software controlling the network configuration and logon process consists of batch files written to prompt the user for a "START" command followed by a logon name. During the computer boot process, the autoexec.bat and config.sys files configure the system to the proper network parameters and assign the appropriate file server and print server depending on the computer's room location. The configuration process also determines the computer's capabilities through the use of variable parameters. This sets the configuration for functions such as modem or 3270 emulation. This is also discussed in Chapter III.

Many user applications are stored on the server in protected read only files and are then copied to the user's computer when called by a user's batch file. A few software application programs are loaded directly onto the user's computer and not on the server. These exceptions are a result of program incompatibility problems or very slow response times. For some programs, like Windows, user access would be too slow with the program installed on the server. For other applications, like Statgraphics, there are compatibility problems using a server and they will only run from the user PC. For a listing of the available Token Ring applications see Appendix A.

B. ETHERNET

The SM labs have two types of Ethernet LANs which are very different in design, hardware and topology. The baseband Ethernet located in room 224 uses a broadcast method of transporting messages along the network. The broadband Ethernet located in room 158 uses a translator unit to transport messages along the network. Both networks are discussed in detail in the following paragraphs.

Although these networks are different in hardware and topology, both use the Ethernet IEEE 802.3 protocol of Carrier Sensing Multiple Access/Collision Detection (CSMA/DC). Unlike the token ring's IEEE 802.5 protocol of managed network access, the Ethernet protocol is a contention system and all transmissions are broadcast over a logical buss. The CSMA portion of this protocol requires the transmitting computer (sender) to

listen to the network to detect a carrier signal. If no transmissions are heard, the computer begins to transmit a message while continuing to listen. If two computers transmit at the same time, the computers would detect a collision (non-normal signal) on the line. After the collision detection (CD), the computers would transmit a "jam" signal to advise other computers that there has been a collision. Each computer uses an exponential backoff algorithm for determining how much time a computer must wait before retransmission is attempted. If another collision occurs on the subsequent transmission attempt, the delay time is doubled.

1. Baseband

The performance of an Ethernet baseband LAN is good for low to moderate traffic. Heavy traffic can slow down a network's response time as computers compete to access the network. The extreme case is when the Ethernet traffic reaches or approaches saturation. This is called an Ethernet meltdown and results in repeated transmission attempts by the network computers. (Feibel, p. 364) Saturation or meltdown is not possible with token ring managed access. As the number of computers increase on an Ethernet LAN or the distances between computers increase, the probabilities of collisions also increase. For a successful Ethernet transmission, the signal propagation delay must be less than or equal to the transmission time. As the cable length increases, the transmission speed (BPS) must decrease to keep an equivalent ratio because the packet size and the propagation speed are usually constant. The parameters for the formula are given in the following equation:

$$\text{(Round Trip)} \quad \frac{\text{Cable length}}{\text{Propagation Speed}} \leq \frac{\text{Packet Size}}{\text{BPS}}$$

- Cable length = twice cable length in meters
- Propagation Speed = speed of signal in medium in meters per second
- Packet size = in bits
- BPS = transmission speed of the network in bits per second

Equation 2.1 Ethernet Transmission Formula

Because Ethernet protocol is not managed access, excessive delays could result if the network has a large number of users or the number of messages are high. These factors may result in transmission rates that are much slower than those advertised by the manufacturer.

a. Hardware And Topology

The baseband Ethernet in room 224 is a thin net 3COM EtherSeries. The shielded RG58 thin net Ethernet cables are rated at 50 ohms and all the required interface circuitry is contained within the network interface card (NIC) which is installed in the computer. The hardware requirements for this network include the IBM compatible PCs, the EtherLink cards (NICs), coaxial cable, BNC T-adapters, Transceiver cables and terminators. For an in depth discussion of these components see (Anderson, p. 14 -15). The server for the 3COM EtherSeries is a 3COM 3Server3 which is not a PC. It differs from the other servers in the room in that it does not have a keyboard or monitor and was specifically designed for use as an Ethernet server.

Ethernets are always a logical bus but their physical topology may be either a bus or a star. The 224 Ethernet (4EN) is a physical star that uses a Cabletron Multiport Repeater as the hub. The advantages of using a multiport repeater include having a cleaner, stronger signal on the bus, extended network operating range as a result of the stronger signal, fault isolation capability as a result of the repeater's auto-partitioning, and the ability to interface with the school's thick Ethernet backbone. The repeater connects to the thick net through the attachment unit interface (AUI) cable. This cable runs from the repeater to a transceiver which is attached to the thick Ethernet cable. Thick Ethernet requires the use of a transceiver that contains the circuitry required to perform the CSMA/CD functions. For additional information on the AUI see (Feibel, p. 206).

The 3COM Ethernet (4EN) has four computers and one server attached to the multiport repeater. The server is also attached to a HP DeskJet 500 printer. Three of the computers, ENET1 - ENET3, are both physically and logically attached to the network. The fourth computer, ENET4, is physically but not logically attached to the Ethernet. See Figure (2.2) for the network configuration.

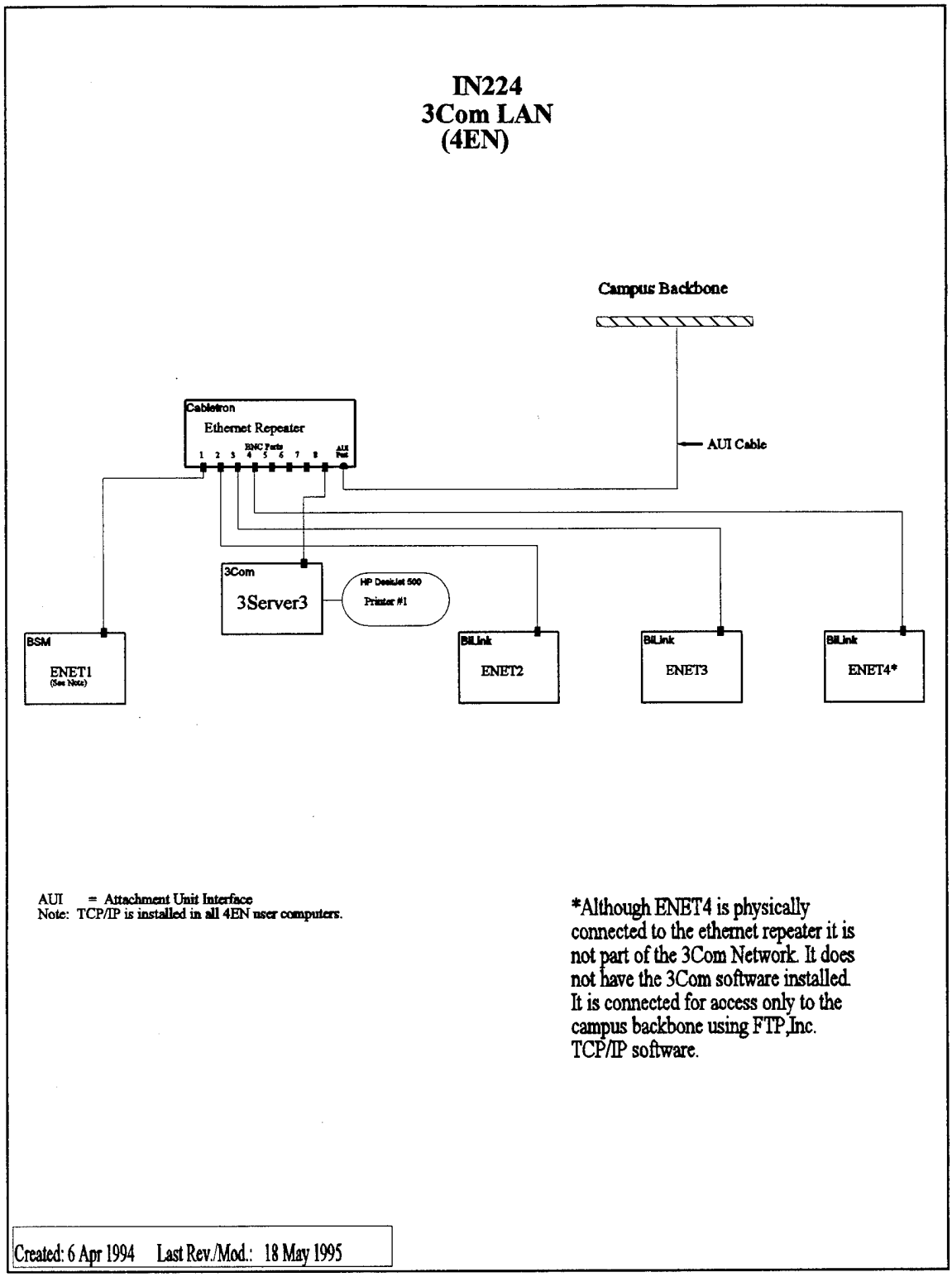

Figure 2.2 3COM Ethernet in room IN-224.

b. Software

The ENET1 - ENET3 PCs are user computers on the 3COM Ethernet. All three contain the user software required to access the server's applications. The 3COM server provides both user applications and print capability. The fourth PC, ENET4, is effectively a stand-alone computer and has access only to the software stored on its internal hard drive. ENET4 uses the multiport repeater to access the campus backbone using TCP/IP, but it cannot access the Ethernet or the printer. ENET4 is configured as a TCP/IP server and is able to store and receive files. This configuration prevents it from being used as a user computer.

All four 3COM Ethernet computers have TCP/IP installed. The three Ethernet computers use IBM TCP/IP software. ENET4 uses TCP/IP software manufactured by FTP Inc. A listing of the 3COM software is provided in Appendix A and a user's manual with a step by step guide to the 3COM system and software is provided by (Anderson, p. 24 - 49).

2. Broadband

The broadband Ethernet (8EN) used in room 158 is an IBM PC LAN Ethernet. Both the baseband and the broadband networks follow the IEEE 802.3 standard using the CSMA/CD protocol. This protocol requires a node to wait until it no longer senses a carrier before it can transmit. The broadband physical star network uses one frequency to transmit and a different frequency to receive messages. The network component responsible for the frequency change is the translator. The translator receives on one frequency and repeats the signal on another frequency. A baseband network, like the 3COM network, does not have a translator. Baseband sends and receives messages using the same digital signals vice different frequencies. Because a broadband is operating on different transmit and receive frequencies, it has greater protection against collisions than a baseband. In broadband, the possibility for a collision only exists between the transmitting PC and the translator instead of between the transmitting PC and the receiving node. In addition to greater collision protection, a broadband network's ability to process multiple frequencies allows broadband to handle multimedia applications as well. This capability could prove more valuable as an increasing number of multimedia uses are applied to PCs.

a. Hardware And Topology

The media used for this network is coax cable. This cable is rated at 75 ohms and has a bandwidth that is capable of supporting multiple frequencies or channels (Feibel, p. 661). The broadband coax is thicker than the thinner thin net coax used on the 3COM system, but is not as thick as the thick net cable used on the campus backbone. The actual physical characteristics of the cables will vary depending on the network utilization (length of cable needed) and the electrical characteristics required.

The network interface board is called a PC Network board and it contains all the components required to interface with the network. Components on the board include software drivers, collision sensors, and an RF transmitter/receiver for message packet transfer.

The network topology is a physical star and a logical bus. The physical star connection is required to allow the implementation of a translator. The star connection is implemented via an eight-way splitter which is connected directly to the translator. This provides increased isolation between PCs and a greater reliability of the system.

The translator is the hub of the network. It allows improved performance by providing a means to receive on one frequency and retransmit on another frequency. This reduces the time delay required before the next transmission can occur. While one PC is receiving a message from the translator on the receive frequency, another PC may begin transmitting a new message on the transmit frequency without a collision occurring. This is the same principle used by Ham radio repeaters which are operating on a frequency offset between the transmit and receive frequencies. Each network is limited to using only one translator.

Other items used on a broadband network include a distance kit and a baseband expander. The distance kit is a kit that contains the cabling, impedance matching accessories, and the connectors that allow PCs to connect at various distances (1 ft., 400 ft., or 800 ft.) from the base expander unit. The base expander unit allows the addition of a multiple length distance kit. By using the expander unit to connect distance kits vice PCs, there can be a maximum of (8 x 8) connections plus (8) for a total of 72 PCs connected to a

network. The maximum distance allowed is 1000 ft. See Figure (2.3) for a layout of the Broadband network's physical connection in room 158.

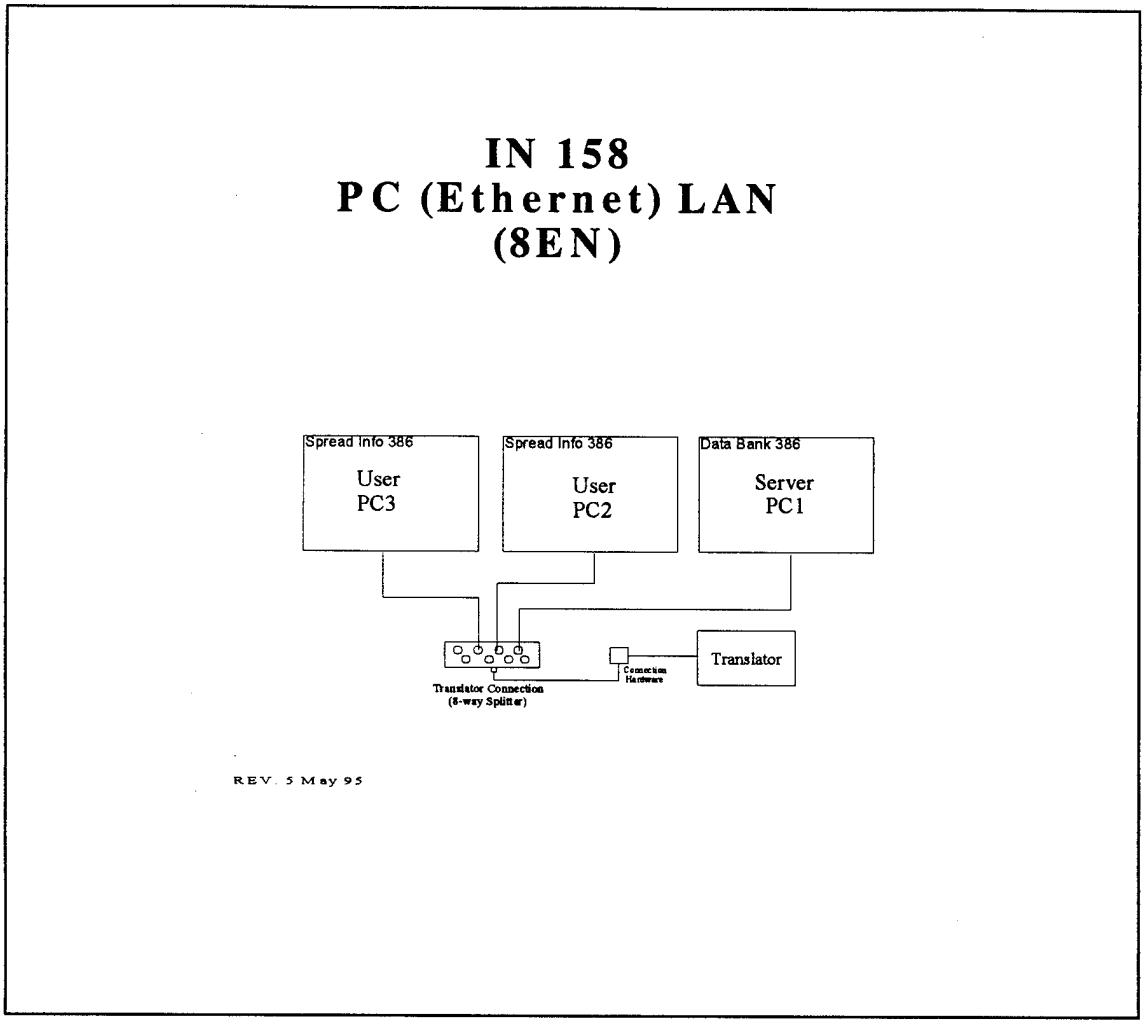

Figure 2.3 Room IN-158 Broadband Ethernet

b. Software

The Broadband Ethernet in room 158 is one of many examples of different network protocols and topologies available to Information Technology Management students during their study of networks for course work and for thesis research. In order to allow students the opportunity to study the network with a minimum of software drivers and distractions, this network has only five commercial applications installed. These applications and their functions are listed in Appendix A.

Located in each lab is a reference binder with information concerning the software and hardware resources available in that room. Most of the software applications have user information available.

C. APPLETALK

The AppleTalk network which is located in room 158, is designated as (8AP). The AppleTalk protocol, designed in the 1980s, was provided as a proprietary protocol suite that would provide network capabilities to Macintosh computers. The goal was to have an easy-to-use, open environment in which any user could just plug in the components and instant network access would be available. The most recent release of Apple's proprietary protocol suite, phase 2, has extended the capabilities and services of the previous version. The physical and Data Link layers have implementations for Ethernet, FDDI, LocalTalk (Apple's protocol), Token Ring, and Serial (RS-422). (Feibel, pp. 32-38)

The AppleTalk network is an excellent example of communications between two different operating systems over one network. The compatibility and limitations of transferring files between the two computers are demonstrated by this network. This network provides an excellent environment for students to increase their knowledge of the issues involved in merging the two system technologies.

a. Hardware and Topology

The AppleTalk network is composed of three Macintosh II fx, three Quadra 950, one Apple LaserWriter printer, and one IBM compatible PC. One of the Quadra 950 computers is dedicated as a file and print server. The network's cable is a shielded twisted pair which is plugged into a two port connector that provides two ports for the network cable and one cable which plugs into the Macintosh (MAC). The port for the computer is a Hewlett Packard RS 422 Transmitter and Receiver port. The transmission speed is slower than other networks at 230.4 KBPS.

The network topology is a physical and a logical bus. To add components to the network, all that is requires is to plug the cable into the computer's LocalTalk port. Each device is a node on the network's bus including the IBM PC. The PC is connected via a

LocalTalk network interface card (NIC) which is installed in the PC. The maximum cable length between nodes is 300 m. and the maximum number of connectors is 32. See Figure (2.4) for the computer lab layout.

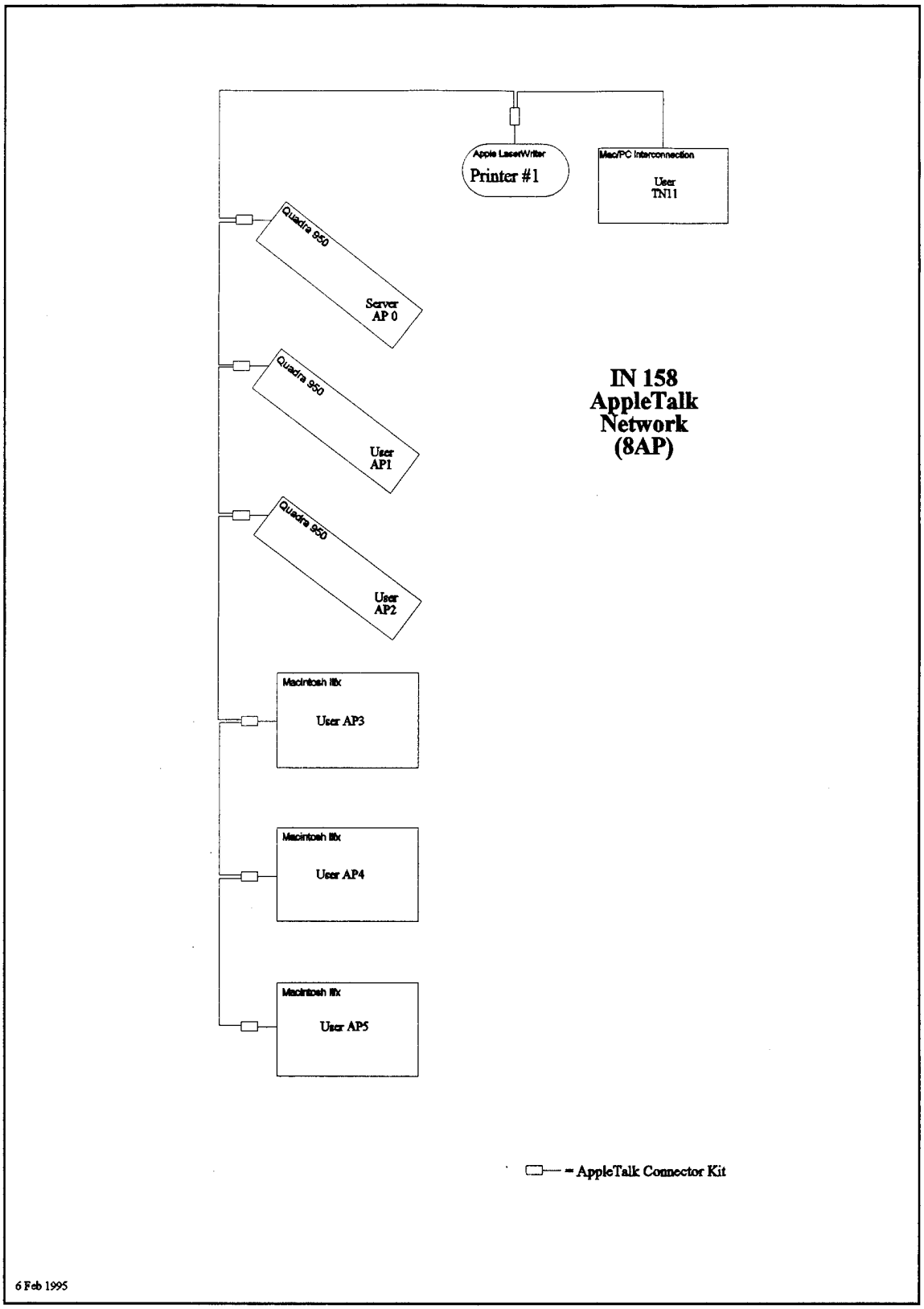

Figure 2.4 AppleTalk Network in room IN-158.

b. Software

The software installed on the Macintosh computer is comprised of the System Seven Operating System (OS) plus the associated bundled software included with the OS. System seven provides basic operating system functions such as input/output control, memory management, and hardware control. A major difference between the MAC operating system and a PC DOS system is that all functions are based on a graphical user interface (GUI) environment to interface with the user. This GUI environment consists exclusively of icons and menus. Included in the OS is AppleTalk which provides for bus access control through CSMA/CA. This protocol is based on collision avoidance not collision detection. The nodes compete for access to the bus by listening to network traffic and then allowing a delay before attempting to transmit. This delay is based on a minimum time plus an additional time which is based on the traffic conditions. A successful transmission is determined by the sender receiving an acknowledgement from the receiver and not detecting a collision like the Ethernet protocol does. There is not a "jam" signal sent after a collision; instead, if an acknowledgement is not received, the message is retransmitted.

The PC computer which is on the network has Microsoft's DOS Version 3.3 installed. DOS 3.3 was required to be compatible with the AppleTalk network interface card installed in the PC. The AppleTalk network software allows resource sharing between the PC, the AppleTalk server, other Macintosh computers, and the printer.

To share resources on the network, menus are used to designate "share" with other MAC computers. If a MAC has allowed share, then all MACs on the network are allowed to share the hard drive resources of the sharing MAC. The MAC server uses a similar menu to allow sharing with other MACs on the network. Only one file can be opened and modified at a time. If more than one MAC tries to access and use a file, an error message appears stating that the file is in use and cannot be opened. This process contrasts with the PC environment in which the server's files can be accessed by more than one PC without an error message. However, in the PC environment, a computer must be configured as a server to share files.

Security and restricted access to files is managed differently on a MAC than on a PC. A PC server can protect files by assigning read only attributes to the files. This allows multiple users to access the files but they are unable to change the file contents.

The MAC server can also protect folders and files, but this places severe limitations on the users. This prevents allowing multiple users to access, change, or save a file. To make the server useful, the folders and files must be allowed unrestricted access to the users.

The MAC to PC connectivity provides a useful test bed for examining the two environments. The contrast between operating systems, GUI and non-GUI user interface, and the network compatibility issues provide valuable insight to potential users and network managers who work in this lab.

III. NETWORK ADMINISTRATION

The primary function of a network administrator is to manage the network in a way that provides the optimum service to the users given the limited resources of time, personnel, and money. Limited resources force tradeoffs to occur when balancing between functionality, performance, and maintenance requirements. LAN management involves five functional areas. These functions are configuration management, account management, performance management, security management, and fault management. (Schatt, 1993, p.125) Four of these areas, configuration management, performance management, security management, and fault management will be discussed using examples from the SM labs.

The advancement of software over the past few years has provided the users with functionality which has never before been available in the PC world. The capability to link documents to spreadsheets, databases, and other files has allowed documents to be instantaneously updated as information changes. Graphical functions have also increased the capability of many users to improve their reports and presentations. The cost of this functionality is an increased burden on the network administrator. As the applications have been migrated to networks, the installation and maintenance times have greatly increased. Applications which are not completely compatible with a network may lose their responsiveness, experience a reduction in their functionality, or may not operate at all in the network environment. Technical information is not always available for network installation and maintenance problems. When information is provided, it is often unclear or incomplete and many hours of trial and error testing are required to correct the problems.

A. CONFIGURATION MANAGEMENT

In an academic environment, the administrator is faced with the additional challenge of providing a consistent environment to the users. The network must maintain this environment from PC to PC regardless of the type of machines or software being used. Items included in this challenge are consistency in appearance, response, and the procedure for using network resources or applications. To achieve this formidable goal, the network

administrator must install and maintain applications on an individual basis and then modify the installation to correct deficiencies or incompatibilities.

Many complex software applications of today are designed for a particular operating system, network, or suite of software protocols to be run with them. Because of this design, applications installed on a network may encounter compatibility problems that would not have occurred on this or another vender's network or on a stand-alone installation.. This paper will address some of the compatibility problems encountered in the Systems Management labs and the solutions, compromises, or limitations which are imposed when a clear solution is not achieved.

B. PERFORMANCE MANAGEMENT

The functionality of a network is a combination of hardware and software operating together smoothly in a cooperative manner. This cooperation or compatibility would be enhanced if hardware and software standards in industry existed, but that is not true. The diversities of hardware and software vendors which provide computer components have been a constant source of problems to LAN administrators. Even the same software vendor may not be compatible (backward compatible) with earlier versions of the product and this requires that the LAN administrator maintain both versions of the software on the network.

Organizations such as DoD, IEEE, and ISO have established some network standards, but these usually address only a limited scope at the lower levels of a network such as the physical and data link layers. Because of poor initial planning, the lack of a standard, and variation of design by vendors, there is currently an industry wide problem of compatibility. An example of the problem is seen in the architecture of the original PCs.

The amount of memory allocated to run programs in the early PCs was 640 K. This was thought to be more than adequate for the operations that would need to be performed, but today applications are requiring more memory to operate. To operate with this restricted memory requires programming tricks, software patches, and even some system programming to work around this design limitation. This will be discussed later in the memory management section

C. SECURITY MANAGEMENT

Security usually generates negative connotations among system administrators and users. This is a result of the approach organizations have historically taken toward computer security. Unfortunately organizations have taken the "one size fits all" attitude and prescribe "The Security Policy" for the entire organization. This is appropriate if the mission and functions are the same through the entire organization, but this is rarely the case. If organizations approached requirements based on need, then the attitudes and support of security policies would improve. Organizations could then require compliance to a minimum set of standards, which would only reinforce what should be common sense, and allow increased security if the operation required it.

Security management can be divided into both physical and system security. The physical security maintained in the SM labs is excellent. Extensive steps have been taken to ensure that the physical security is maintained at the highest level.

These steps include door locks to each lab with the recording of user's who receive cipher codes, quarterly changing of cipher codes, security cables connected to the various hardware items in the lab to deter theft of the PCs ,boards, and mouse; and a weekly lab checklist to monitor and verify the status of lab resources. Lab ADP security policies are posted on the wall in each lab and on users' logon screen. The wall posters provide users with the policies and the points of contact to report any discrepancies.

The system security features include hardware and software measures. The hardware limiting features include keyboard locks on server PCs that enhance server security by restricting operating system access. The software security includes virus scan of user PCs on boot up, read only drives of the servers, password protection for server maintenance, and the removal of configuration control icons from the windows desktop. Although the users can change the user PCs through DOS commands, the configurations of network applications are loaded from the server and are resistant to modifications from the users.

D. FAULT MANAGEMENT

The ambiguity generated by early defacto industry standards and the rapid advancement of technology have been key factors in contributing to the compatibility issues and challenges of today. Although some vendors conform to the general intent of the network standards, there are many vender unique deviations. These differences are even more pronounced in the software application area. This section will highlight some problem areas encountered in the SM labs and review the technique used to eliminate, minimize, or work around these hardware and software areas.

1. Problem Areas Encountered In The SM Labs

a. Memory Management

Problem: Memory management is required to allow applications to run after the loading of DOS, NOS, and the PC LAN Support Program.

Memory management is a crucial component of any computer system and this is especially true if the computer is attached to a network. Due to the early design architecture of the PC, a limitation of 1 MB of addressable memory has been inherited by our current PCs when operating under DOS (See Figure 3.1).

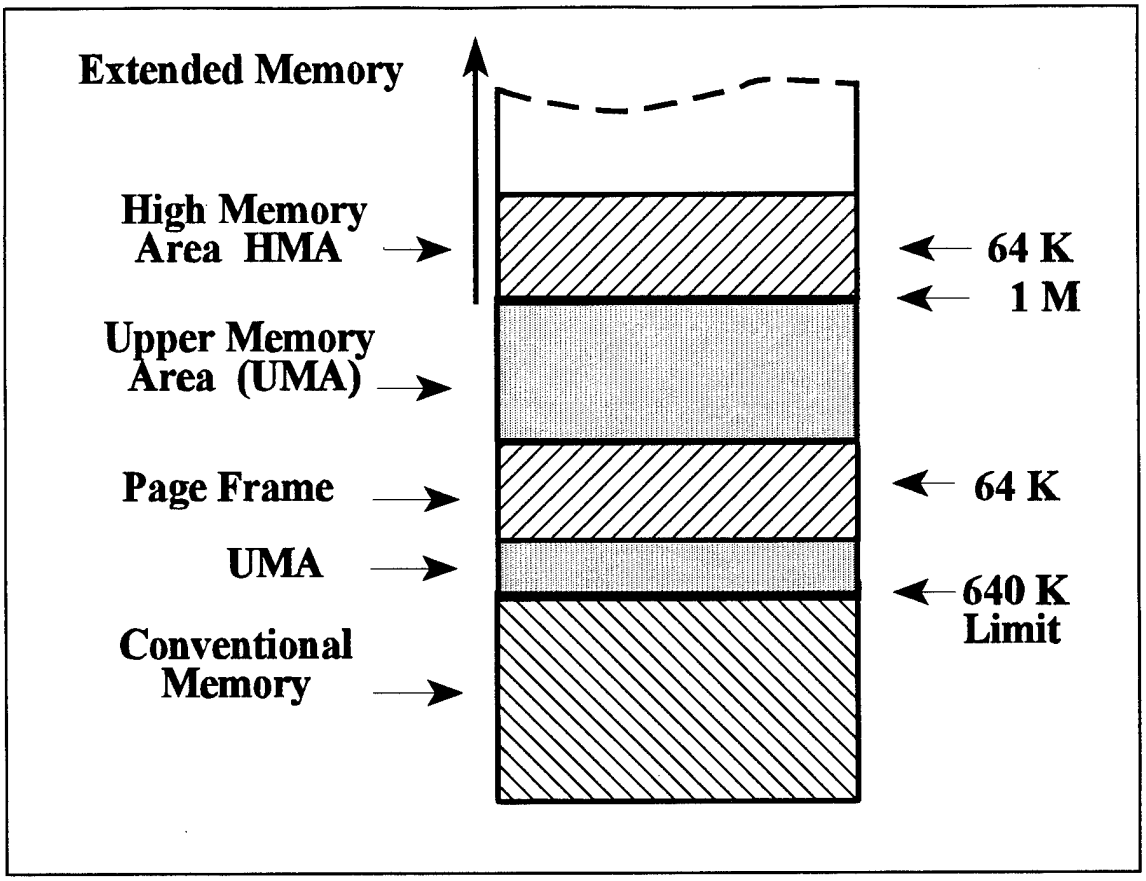

Figure 3.1 Typical PC Memory Representation (Schneidewind, 1995)

Within the 1 MB of addressable memory, only the first 640 KB was available to execute programs. The term "640 KB Barrier" is used to describe this limitation. The area from 640 KB to 1 MB is used to map system ROMs, memory-mapped I/O devices, and device drivers. Table 3.1 compares six classes of PCs and their respective memory upgrade and memory management capability. For additional information see (Goodman, pp. 45-47).

Category	I		II		III	
Maximum Extended Memory	0 MB		15 MB		4 GB	
Upper Memory Blocks	NO	YES	NO	YES		
Run 32-Bit Instructions	NO				YES	
Processor Type	8088 8086	8088 8086*	80286	80286*	386SX	386DX 486SX 486DX
Class	1	2	3	4	5	6
* Processor requires special hardware						

Table 3.1 The Six Classes of PC for the purpose of memory upgrades and memory management From Ref. (Goodman, 1992).

Originally this arrangement met all the system requirements and allowed adequate room for the applications. As additional functionality was added, modules were developed that would terminate-and-stay-resident (TSR) after performing their function. These TSRs were not able to detect the presence of each other and could conflict with the memory area that they were assigned. This competition for scarce memory resources leads to the need for a tool to assist DOS in resolving this problem. (Deitel, 1992, pp. 6-7)

Current versions of DOS have a built-in memory manager which can be used to load program drivers outside the 640 KB of conventional memory. The memory manager used

in the SM labs is called QEMM.[1] In addition to providing more functionality by making more memory available, QEMM has a report feature that provides the LAN administrator with the usage and mapping of the system. For additional information on QEMM by Quarterdeck, see (Bailes, pp. 202-221).

In a network environment the LAN manager tries to free as much conventional memory as possible. By loading devices and portions of the operating systems (OS) in upper and high memory areas, more conventional memory area is released to be used by applications. The loading takes place in the config.sys file and the optimal loading sequence is accomplished primarily by trial and error. The help provided by the technical reference manuals is minimal and only after hours of testing can the desired results be obtained. Documentation of the configuration is crucial because all parameters, including the order in which the steps are accomplished, can effect the outcome. Figure 3.2 contains an example of memory management using a config.sys file.

[1] QEMM is the copyrighted name of Quarterdeck Software's memory manager.

```
REM ** IS 3503 Lab #4 Assignment          W. Melvin Steedly **
REM ** CONFIG.SYS File                    3 FEB 1995        **
REM
REM ** Define the COMMAND.COM setup with a permanent copy in the shell     **
REM ** and set the environment size to 512 bytes.                          **
SHELL=A:\COMMAND.COM/P/E:512
REM
REM ** Load QEMM into UM memory area; RAM switch allows extended memory **
REM ** to be used as expanded memory; Assigns protected RAM areas to      **
REM ** prevent overwriting specific memory areas by QEMM.                 **
DEVICE=C:\QEMM\QEMM386.SYS RAM ARAM=D800-DBFF AROM=CC00-CDFF
REM
REM ** Load DOS Kernel into High Memory Area (HMA)                        **
DOS=HIGH
REM
REM ** Load all drivers into Upper Memory (UM) and define NETWORK         **
REM ** characteristics: term.(ST) 23, sessions 10, CMDs 5                   **
DEVICE=C:\QEMM\LOADHI.SYS /H A:\NETWORK\DXMA0MOD.SYS 001
DEVICE=C:\QEMM\LOADHI.SYS /H A:\NETWORK\DXMC0MOD.SYS
DEVICE=C:\QEMM\LOADHI.SYS /H A:\NETWORK\DXMT0MOD.SYS ST=23 S=10 C=5 ES=1
REM ** Set the DOS Version and ANSI escape sequence then LOADHI and      **
REM ** load RAMDRIVE in UM and allocate 1280K for RAMDRIVE E             **
DEVICE=C:\QEMM\LOADHI.SYS /H A:\DOS\SETVER.EXE
DEVICE=C:\QEMM\LOADHI.SYS /H A:\DOS\ANSI.SYS
DEVICE=C:\QEMM\LOADHI.SYS /H A:\DOS\RAMDRIVE.SYS 1280/E
REM ** Set the Max number of files to open and Allocate the # of    **
REM ** buffers to allocate in memory.                                 **
BUFFERS=20
FILES=20
REM ** Set the Max # of file control blocks that can be open to 1     **
FCBS=1
REM ** Set the last drive available to limit memory allocation.       **
LASTDRIVE=M
```

Figure 3.2 Example of Using A Memory Manager To Provide More Conventional Memory.

b. Network Installation of Programs

Problem: Each program installation on a network has unique requirements that lead to installation errors.

The installation of network applications is extremely complex due to the flexibility that is being built into the applications. After typing the install command, the network administrator is required to make various choices concerning directories, directory protection, and system initialization files.

The current trend of companies is to provide most documentation as *readme files* on the disk and only provide a minimum amount of hard copy instruction and help. Great care must be taken by the administrator as he assigns the drive, and directories to ensure that the properties assigned to the user are in compliance with the requirements of the network and application. On several occasions, a program has halted due to a share violation or when an attempt to write to a read only directory was made. This mis-assignment of drive attributes and properties can often be attributed to the lack of documentation describing how the various files are used in an application and to errors made during installation of these complex applications.

Previous installation experience has not always been that helpful in installing a new version. One vendor changed file names and added files to perform the same function as a previous version. This is even more confusing when installing different vendor products as seen in the way various vendors handle license agreements. Some vendors use a license utility that tracks the number of copies in use. This requires a writable directory. Unfortunately problems are introduced when the applications are exited in a nonstandard method because the license is still considered in use by the license utility and a new user may not be allowed to access the program.

c. Network Compatibility

Problem: Hardware and software incompatibilities prevent 3270 Emulation on some models of PC compatible computers.

IBM compatible computers did not allow 3270 Emulation when attempted on the network. It is suspected that incompatibility between the hardware's video card and the emulation software caused the problem. Due to the nature of the DoD procurement system, neither quality nor vendor can be controlled or requested by an organization. This system allows items to be purchased at a lower price, but does not allow for the screening of quality components or system compatibility. Because of this problem, the solution for obtaining 3270 Emulation was to substitute another vendor's PC which did not exhibit the incompatibility problem.

d. Network Printing

Problem: Programs will not print until program is exited.

Several of the DOS based programs installed in room 224 will not print until the program is exited. This is due to the incompatibility of the NOS and the application. The NOS does not receive the "end of file" notification until the program is exited. There is no current solution to this problem, but the users are made aware of the problem to prevent multiple print jobs from being sent to the print server. The typical user will reissue a print request if no output is obtained while in the program. This results in wasted printer resources if the users are not informed.

Problem: Network is limited in the size of the output that it will accept.

With the extension of the Token-Ring network from rooms 224 to 250, a print problem was also transferred to room 250. The network is limited in the size of file that the print server will accept or process. This problem will occur if:

- Condition (1): A large print file is sent, such as multiple pages or a high quality resolution graphic.
- Condition (2): Multiple users send a printout to the print server at the same time.

Either of these two conditions may result in errors on the network print server. Condition (1) usually just gives a partial graft or a partial document while delaying the print server until the print request clears the buffers. Condition (2) usually gives a message stating that too many files are open, close files before continuing.

The exact cause of this problem has not been identified, but it is suspected that there is a compatibility problem between the network operating system (NOS), IBM PC LAN,[2] and the PC's operating system MS DOS[3]. Further testing needs to be completed to confirm the cause of this problem and then implement a solution.

---

[2]IBM PC LAN Version 1.21 manufactured by International Business Machines Corporation.

[3]MS DOS manufactured by Microsoft Corporation.

The network users may work around this problem by using one of the following methods:

- For printing of large documents, the users may print by selecting only a limited number of pages per printing until the document is completed. The number of pages selected will vary depending on whether there are tables or graphs included in the selection.

- Graphs may be printed by selecting only the page containing the graph and then selecting a lower quality of resolution for the output such as medium or low resolution.

- The third option, which is more time consuming, is to save the WordPerfect document in WordPerfect 5.1 format and then print the document in the computer center's LRC network in room 151. If this method is used, the user must view the document before printing. This is to confirm that the layout did not change when the document was reformatted for the default printer. If the default printers are different, the document layout of any graphs and tables may change within the document.

E. FUTURE OUTLOOK FOR NETWORKS

The future out look for the network administrator is much brighter. The trend to open, portable networks and applications is forcing more standardization among the various vendors. The migration toward open systems may improve the compatibility problems between the networks and the applications, but the hardware and software compatibility problems will still exist.

Network management programs are being released which will allow the network to be managed from a GUI environment. These programs which identify the bottlenecks in both hardware and software are able to assist in optimizing the networks. The software tools that are now emerging should alleviate many administration headaches encountered in network management. By optimizing performance, these tools will provide users with improved operating characteristics, but they will not provide a solution to the compatibility issues that have always presented the greatest problem to network managers.

IV. THE LAN USER

The task of providing new technology to a user audience requires a thorough understanding of the technology and the user. Understanding the user audience includes knowing the general background of the users, the needs or requirements of the users, and the tools available to communicate with the users. For the transfer of technology to be successful, the users must see themselves as more of a team with the technical staff than as mere customers. As discussed in Chapter III, the network support staff has an extremely demanding task administering and maintaining the network. This complex task, coupled with the continued reductions in funding for personnel and hardware, makes the successful operation of the network a task that will require mutual support and cooperation on the part of all involved. The goal of effectively providing resources to the users can be achieved more easily when there is a smooth flow of communications between the users and the support staff. Just as the issues and responsibilities facing the network administrator were discussed in Chapter III, this chapter will discuss the user audience, the needs and requirements of the user, and some basic user responsibilities which will positively contribute to the team effort.

A. LAN USER CONSIDERATIONS

Knowing the user's background and technical expertise is critical in matching the user and the system's features. There are three components that should be considered when describing the user audience. These are the relative level of computer expertise or experience; the general background, training, or education; and the attitude the users have toward the system, staff, or organization. (Brockmann, p. 58, 1986)

The users of the SM labs have not changed significantly over the past years. An analysis of the user audience was prepared by Clark (1991) during thesis research and is given by the following elements:

- Level of computer expertise: The range for this audience varied immensely, with experience extending from the novice to the dedicated computer user, to those with both job experience and baccalaureate degrees in the computer field. Few are expected to have had experience on a network.

- Occupation: Students in the (SM) Department at the Naval Postgraduate School who are pursuing advanced degrees in the administrative, managerial science, or information system area. Most have been trained in some technical or managerial field in which they have been working for a number of years.

- Knowledge about the field and subject: Although many have at least an idea of what word processing is about and have even used such programs previously, most potential users ... are presumed to have little experience with ...(word processors).... (See information update in following paragraph.)

- Position in organization or field: The prospective audience is students and faculty at an academic institution (NPS).

- Level of education: The prospective users have at least a baccalaureate degree.

- Age group: The students ... are older than average for graduate students, but a variation in age from mid-twenties to mid-forties is expected.

- Reasons for using the program: Students are expected to ... create reports and research papers... (for assigned courses).

The analysis also stated that the students would progress over time from a possible novice level to a more experience computer user and would require user guides of a more advanced nature. (Clark, 1991)

The Departmental requirements and the current user profile have changed since Clark's analysis. The SM Department now requires new students to take an introductory course to computers in their refresher quarter. This course covers three modules that include basic DOS commands, word processing, spreadsheets, and presentation software for creating briefs. Students with previous experience in these areas are allowed to validate portions or all of the course. Course records indicate that the number of students validating these courses have continued to rise (Table 4.1).

School Quarter	Number Enrolled	Number Validating WordPerfect	Percentage Validating WordPerfect	Number Validating Lotus 1-2-3	Percentage Validating Lotus 1-2-3
Summer '90	182	1	0.55%	9	4.95%
Winter '90	88	24	27.27%	5	5.68%
Summer '91	168	23	13.69%	32	19.05%
Winter '92	102	10	9.80%	15	14.71%
Summer '92	166	34	20.48%	32	19.28%
Winter '93	108	23	21.30%	20	18.52%
Summer '93	182	35	19.23%	22	12.09%
Winter '94	102	31	30.39%	25	24.51%
Summer '94	150	58	38.67%	42	28.00%
Winter '95	72	34	47.22%	23	31.94%

Table 4.1 Validations For IS 0123 (Lindsay, 1995).

As these figures indicate, many students are arriving with previous computer experience and after the first quarter at school all students will have had some computer and network experience. This is a significant baseline for user knowledge and allows future user training and documentation to start at this level of expertise.

B. USER NEED REQUIREMENTS

The users of the SM labs depend on the lab resources to meet many of their course requirement needs. The range of computer related requirements include tasks such as word processing, performing statistical analysis, and making class presentations. This range of needs is indicative of the variety of software that is available in the labs (Appendix A). With the prominence of Windows and the GUI environment, more users are expecting to be able to work with Windows in the labs. Lab 250 currently has Windows and the lab in room 224 will be getting Windows in the near future. Currently the user computers start on the

1DirPlus screen, which is a file manager program, and then select Windows from the menu. This may soon change with the large number of Windows programs that are being installed. The initial screen could be the Windows desktop and users that need to access DOS or run a DOS program would just run the program under Windows.

C. USER RESPONSIBILITIES

The SM labs will operate more smoothly when there is a spirit of cooperation between the support staff and the users. This sections discusses some key areas of user responsibilities in supporting this cooperative spirit.

1. Security

The first item of responsibility is security. The SM labs have the best physical security policy of any labs on campus; however, the policy is only as good as the users who comply with the policy. Each lab has the security policy posted within the lab for the convenience of the users. This policy addresses both physical and data security. The users are responsible for ensuring that only authorized users have access to the lab. This is achieved by not letting anyone into the lab who does not have the cipher code. Access codes are easily obtained from the office and provide the lab staff with a listing of the user base that it is supporting. The physical security of the hardware is also important but the physical restraints currently on the equipment are a reasonable deterrent to theft.

2. Software

The software applications in the labs are provided for the exclusive use of the students and faculty. To comply with current copyright laws only authorized versions of software are allowed to reside on either the server or user PC. If someone suspects that some software is not authorized, it should be reported to the lab staff. Users are not allowed to install software in the labs. If a software application is needed, this must be coordinated through the Lab Director or Network Specialists. They can bring the requirement to the attention of the

Lab Committee. Faculty members who have software requirements must also coordinate their desires. This avoids introducing software compatibility problems into the network and allows proper configuration management of the network and software tracking for audit purposes.

Virus protection, which is related to data security, is another area of concern. The computer labs have virus protection installed which protects the PC and their hard drives during the PC's initial start process but it does not protect the user's data. Users should scan their disks with the installed virus detection software if there is any doubt as to the condition of a disk. This is especially true if files were downloaded to the current disk from a bulletin board. Viruses may or may not give the user a warning of a problem. A few signs to look for include an application that begins to respond in an unusual manner, a computer that seems to be operating much slower than normal speed, usable disk space that is decreasing rapidly, or available memory which is decreasing. If any of these characteristics appear, the user should take responsible steps to identify the problem. The first step would be to scan the software. If a virus is detected, make sure that the staff is aware of the problem as soon as possible.

Software backups are another area of concern. Data should be saved on a personal disk and not on a user PC or on the server. Data saved anywhere other than a personal disk may be erased by the next user. It is important that the user periodically backup data during a work session. The word processor in the labs automatically save data every ten minutes. If this is not frequent enough, the default time can be changed or the user can manually save the data. A user only has to lose data once to learn how important backups are.

3. Communications

A vital factor in having a smooth operation is communications. It is imperative that users keep the lab staff informed of any problem encountered in the labs. There are forms available in each lab to allow users to report problems. Classes are often conducted in the labs and it is impossible for the lab staff to individually check each computer. A written problem report is the only way problems can be documented and corrected in a timely fashion.

Besides reporting problems, users should also forward suggestions. The Department has a Lab Committee composed of the Department Chair and five faculty members. Students or faculty who have suggestions should contact one of the committee members to forward their suggestions. Presently there are no suggestion boxes in the lab for this purpose. The Lab Committee serves to evaluate suggestions and assign priorities to the submissions that are approved. By assigning a priority, the lab support staff can know which projects are more important to the department and respond to the highest priorities first.

V. TECHNOLOGY TRANSFER

Technology transfer is an important issue in our society. As the technology becomes more advanced, there is an expanding gap between the users and the technology. A great deal has been done in system design to try to narrow this gap through the use of menu driven programs and GUI environments. To a new user even a Windows environment is a challenge, with unfamiliar screens displaying commands such as "click" or "close" in reference to the displayed buttons. In spite of all the overall excitement that people exhibited for new technology, when the average adult user confronts new technology on a personal level, the previously displayed excitement diminishes. Individuals would usually rather stick to their old familiar way of doing business than try to learn something new. The challenge for the industry is to motivate the individual to embrace the new technology instead. When new technology is accepted by the users in their daily work routine, then and only then can it be said that there has been a true transfer of technology. This chapter will examine the resources that have been used to transfer technology to new users and apply these resources to the students and faculty of the SM labs.

A. ISSUES CONCERNING TECHNOLOGY TRANSFER

The primary means of supporting users of technology is through the use of system documentation. This documentation has traditionally been in paper form but that is changing. Although the most common form of documentation continues to be paper manuals, other forms of media include video support and on-line documentation. This section will primarily focus on paper documentation and the issues that are relevant to producing usable high quality documentation.

The first consideration when producing documentation is defining its purpose. Documentation has historically been viewed as either an instructional function or reference, but Weiss (1991) suggested that the instruction function be further divided into orientation and guidance. The orientation function trains new users with tutorial materials. Guidance demonstrates processes which are more appropriate for experienced users. Reference material contains a condensed presentation of facts that are useful to experienced users who

know what they need, but lack certain details of the specific operation. An additional category, motivation, was added to this list. Although motivation has been omitted in many manuals, its purpose is to counter the reluctance of users to use the system.

The function of a document should be narrow in scope. Many times a single document has been written to address all requirements. This has led to a diluted, confusing, and poor document which frustrated the writers and discouraged the users. The purpose of the manual in Appendix B is to provide the new user with an overview of the SM labs and provide a working knowledge of the resources in rooms 224 and 250.

1. Product Knowledge

The first step in producing a good document is to know the product which the document is supporting. Typically the system designers and engineers are not the individuals who produce the system documentation. This disparity creates a high potential for errors to be introduced into the documentation of the system. To minimize this potential for errors, it is critical that representatives of the technical staff review the draft documentation for technical accuracy. This technical review should be accomplished by someone who is not involved in drafting the document, because an independent review is able to identify more errors than a review by someone who has previously been working on the draft. For this case study, the LAN analysis completed in Chapter II has provided the product knowledge required to document the system and the application on the network. The technical review was incorporated into the thesis process.

2. Knowledge Of Users

The second requirement in producing system documentation is knowing your user audience. Although this audience may vary over time, the document preparation must consider this variance and then write to the lowest common level of the targeted audience. As shown in Chapter IV, the audience in the SM labs has changed over time. Initially very few of the new students had computer experience upon arriving, but the most recent classes have demonstrated an increase in the initial experience level and proficiency. Based on the analysis of new students and a change in the curricular matrix, it can be assumed that all students will have had some computer experience due to previous computer experience or

an introductory course to computers during their refresher quarter. Establishing a base line for user experience allows the manual to avoid some of the more detailed documentation required of a less experienced user (Brockmann, 1986). The user manual is written to capitalize on this experience and avoid some of the detailed step-by-step explanation of commands and terminology.

Documents have been shown to be more effective when organized by tasks (Clark, 1991). When the document is organized based on a user-task matrix, the user will experience increased usability of the document and there will be less frustration created by searching the document to find a related but different task. The tasks in rooms 224 and 250 involve mainframe communication, applications software, and peripheral devices (Appendix B).

3. Documentation Quality

The quality of the documentation depends on many factors, many of which are out of the document drafter's control. Because most documentation is planned after-the-fact, it cannot be used as a tool to identify problems and correct deficiencies in the system. At best, the documentation can only point to weak areas and attempt to guide the users successfully beyond them. (Weiss, 1991)

When preparing documentation, the system, the audience, and the tasks performed must be studied. The purpose of the document must be kept on target and have a single function. If more functions are required, then additional manuals should be planned. The format of the manual should be constructed in a manner that seems logical to the user. When multiple manuals are required, each manual should be consistent in regard to layout and organization.

4. Media Selection

Choosing the appropriate media is important in presenting the material. The four primary media for documentation includes manuals, brochures, reference cards, and on-line documentation. The advantages of each media are given in the following:

- Manuals: easiest method for distributing documentation. Tends to emphasize complexity because all operational details are covered.

- Brochures: appropriate for top management documentation. Tends to present an image of system simplicity by presenting the subject in a minimum number of pages.

- Reference cards: may be of two types, abbreviated or full-disclosure. Abbreviated assumes previous knowledge on the part of the user. Full-disclosure provides more information to the user. Size of card allows conveniently posting on or near the computer or keyboard. Narrow in scope and services one audience and one purpose. (Brockmann, 1986)

- On-line documentation: provides immediate access to requested information when needed. More appropriate for information which is needed a section at a time vice lengthy or detailed retrieval (Horton, 1990).

The various forms of media need not be used exclusively and may be used in combination to enhance the understanding and effectiveness of the user. Presently most manufacturers of software use a combination of manuals and on-line resources to assist the users.

B. METHODS AVAILABLE FOR THE SM LABS

In analyzing the SM labs, it appears that the most appropriate methods for use in the labs have been used. The forms of media used consist of manuals, reference cards, on-line documentation, and video projection.

The manuals in use at this time are primarily commercially produced manuals that accompanied the purchased products used in the labs. Network and application manuals have been written. These manuals were intended to cover specific topics and not all resources in the lab. The manual in Appendix B provides a user guide to the total lab by addressing the other resources available in the labs. This manual will be placed with the other manuals in the lab that are located for convenient user access.

Additional documentation in the labs is provided by reference cards. All of the computers have reference cards, which provides instruction for the network logon procedures. The cards are located on the desks where they provide a convenient reference and are available without reducing the available working space.

The on-line documentation is provided to assist the users on several of the unique capabilities of the network. Automatic documentation is provided to users when using the TCP/IP applications, the 3270 emulation, or the modems. The on-line displays tell the users which computers are capable of the function that is requested and it advises the user of the procedure for exiting the program. Other on-line documentation is provided within the software packages installed on the network. The software documentation is provided by the software manufacturer.

Video projection is also provided in rooms 224 and 250. The projectors provide a media for the instructors to provide guidance and instruction to the students in the various lab courses. The Video projection is very beneficial during group instruction and receives its input from the instructor's computer.

VI. CONCLUSION

The study of technology transfer using the Systems Management Department's LANs as a case study has revealed an environment with many dynamic elements which are involved in the transfer of new technology to users. Transferring technology to users is much more involved than just producing a good manual. This transfer involves three key elements that are integrated to produce the resulting outcome. The three key elements consist of the system, the users, and the support staff, all working together in a team effort. This interaction transfers the technology to the users that allows the optimum use of available resources.

The system is the primary element in this environment. The strengths and weaknesses of the system must be known and thoroughly documented to make the users aware of the system's capabilities and limitations. Researching the SM LANs revealed the challenge and complexity presented to the LAN support staff. Challenges are presented each time a new application is added to the network. As technology advances, many existing networks are not designed to support the complexity presented by the newer applications. Creativeness is required by the support staff to work through the network incompatibilities and make the network work. Sometimes the software incompatibilities result in network performance that is not completely reliable, which leaves the users and the support staff dissatisfied with the results. Also of great importance is whether DOS, NOS, Windows, PC hardware, and network hardware will all work compatibly. Historically it has been documented that maintenance is the major cost of any computer system and this cost is reduced by maintaining a network that is compatible with current technology. For users to be satisfied with the service, it is critical that the system be maintained at an acceptable level of performance through modernization and adequate staff support.

The obvious focus of technology transfer is on the users. In the SM labs, the users consist primarily of students and faculty in the Systems Management Department, but other curricular and departments also use the labs. Previous research provided by Clark (1991) and the updated information in this study, reveal that the students' computer experience levels are progressively increasing over time. The positive aspect of this is that less documentation is required for the user as detailed documentation. The negative aspect of a more sophisticated

user is that more is expected from the network in terms of capability and response time.

Users also have a responsibility to be an active part in the maintenance of the network. With problem reports, network problems can be identified and corrected in a timely manner. Other user contributions to the network include complying with the lab security policies and guarding against potential virus threats (Appendix B, SM Lab Forms and Instructions).

The support staff is the third key element in the successful transfer of technology. The support staff must be diligent in providing user support in both system maintenance and user documentation. In this case study, multiple forms of media documentation support the users in the labs. These materials include manuals, reference cards, and on-line documentation. This variety of documentation is commendable and provides the users with many items necessary to use the network. As stated by Wiess (1985), documentation should be usable, appropriate, accessible, and reliable. Existing documentation is periodically reviewed and updated to remain usable and appropriate. The manuals, that are provided, are located so that they are easily accessible by the users.

In addition to system maintenance, the support staff has a responsibility to communicate to the users the network's operational status and future configuration changes. Support has been provided in the way of lab newsletters, notices in the SM departmental newsletter, and in log-on messages. This open communication between the support staff and the users promotes better understanding and use of the network's resources.

To facilitate the transfer of technology to the users, a user resource manual has been produced (Appendix B). This manual provides a comprehensive guide to the network resources in rooms 224 and 250. To assist in the dissemination of this information to the users, this manual could be provided to the new users in the following situations:

- Provide the manual to the new users during the computer indoctrination course which is offered during their initial quarter at the school.

- Provide the manual as a reference in the IS 3503 computer network course.

- Place the manual in the two labs with the other lab manuals to allow users full access to the manuals.

In conclusion, the transfer of LAN technology to users is a dynamic process that involves three key elements. The key elements, which consist of the support staff, the users, and the system, must all contribute to the process in order to have a successful transfer of technology. The combination of reliable performance from the system, adequate and comprehensive documentation for the users, and open communication between the lab staff and users, will provide not only the maximum transfer of technology to the users, but also provide the optimum use of the resources available.

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APPENDIX A: SOFTWARE APPLICATION RESOURCES

Software applications available in the various Systems Management Labs are listed in the following appendix.

Applications Matrix For Room I-158

This Software Applications Matrix identifies the 1DIRPLUS application file name, application function, and the application version. There is only one matrix screen in this lab due to the smaller number of applications:

IBM PC Broadband Ethernet (8EN) Room I-158 Applications	
Menu Item	**Function**
1DirPlus Ver. 3.02	File Manager
Lotus 1-2-3 Rel. 2.3	Spreadsheet
VSHIELD (Current Version)	Virus Monitoring Program
WP51 DOS VER. 5.1	Word Processor
QAPlus Rel. 4.5	Computer Diagnostic Program

Applications Matrix For Room 224

The Token Ring and the Ethernet networks provide numerous applications for the users in room 224. This matrix identifies the applications, and the associated network or computer that it is on. The Software Applications Matrix is listed by the screen on which it would appear:

Software Application Matrix For Room I-224 Networks Screen 1		
Application & Version	**Function**	**Network or Computer**
1DirPlus V.3.0.2	File Manager	4TR & 4EN All
ACOL V.1.0	Costing Model	4TR - All
AFM V 1.4	Air Force Acquisition Model Supplement	4TR - All
CD ROM	Read Only Optical Device	4TR - TN36
FTP, FTP,Inc. V. 2.11	File Transfer	4TR - All
LOTUS 1-2-3 DOS V.2.3	Spreadsheet	4TR - All
Mainframe IBM PC 3270 Emulation V.3.03	3270 Mainframe Terminal Emulator	4TR - Designated Computers
Paradox V 4.0	Relational Database	4TR - All
Ping, FTP, Inc. V.2.11	TCP/IP Internet Address Query	4TR & 4EN - All
Scanner AST EyeStar V. 1.35	Graphic/text Scanner	4TR - TN25
SIMPC60	Modem Communication	4TR - Designated Computers
SMERFS V 5.0	Reliability Tool	4TR - All
STATGRAPHIC V. 5.3	Statistical Analysis Tool	4TR - All
TELNET, FTP, Inc. V. 2.11	TCP/IP Remote Logon	4TR - All

Software Application Matrix For Room I-224 Networks Screen 2		
Windows V.3.1	Windows Desktop	4TR - All
WP51 DOS V. 5.1	Word Processor	4TR - All

The following ethernet applications appear on the 3COM EtherSeries network:

Software Application Matrix For Room I-224 3COM EtherSeries Ethernet Screen 1		
Application & Version	**Function**	**Network or Computer**
!Wonder V. 3.02	File manager	3COM network, ENET1 - ENET3
DBase Aston-Tate V.4.1	Relational Database Program	3COM network, ENET1 - ENET3
Email EtherSeries V. 2.4	Email Application	3COM network, ENET1 - ENET3
Eprint EtherSeries V. 2.5	Print Program	3COM network, ENET1 - ENET3
FTP FTP, Inc. V. 2.11	File Transfer	3COM network, ENET1 - ENET3
Help EtherSeries V. 3.4	On-line Help File	3COM network, ENET1 - ENET3
Logout EtherSeries V. 3.4	Exits the Ethernet	3COM network, ENET1 - ENET3

Software Application Matrix For Room I-224 3COM EtherSeries Ethernet Screen 2		
Application & Version	**Function**	**Network or Computer**
Ping FTP, Inc. V. 2.11	TCP/IP Internet Address Query	3COM network, ENET1 - ENET3
SGPLUS V. 5.3	Statistical Anlalsis Tool	3COM network, ENET1 - ENET3
SMERFS V. 5.0	Reliability Tool	3COM network, ENET1 - ENET3
Storyboard V.1.1	Graphics Utility	3COM network, ENET1 - ENET3
TELNET FTP, Inc V. 2.11	TCP/IP Remote Logon	3COM network, ENET1 - ENET3
Virusck McAfee V. 5.5	Virus Scann Utility	3COM network, ENET1 - ENET3
WP51 DOS V. 5.1	Word Processor	3COM network, ENET1 - ENET3

Applications Matrix For Room 250

The Token Ring network (0TR) in room 250 contains both DOS and Windows applications. This Software Applications Matrix identifies the 1DIRPLUS application file name, function, and network or computer used.

Software Application Matrix For Room IN-250 Network Screen 1		
Application & Version	**Function**	**Network or Computer**
1DirPlus V.3.0.2	File Manager	0TR - All
ACOL V.1.0	Costing Model	0TR - All
AFM V 1.4	Air Force Acquisition Model Supplement	0TR - All
CD ROM	Read Only Optical Device	0TR - N10 (Only computer)
CRITERUM	Decision Support Model	0TR - All
FTP, FTP, Inc. V. 2.11	File Transfer	0TR - All
LOTUS 1-2-3, DOS V. 2.3	Spreadsheet	0TR - All
Mainframe, IBM PC 3270 Emulation V. 3.03	3270 Mainframe Terminal Emulator	4TR - Designated Computers
Paradox V. 4.0 (WIN)	Relational Database	0TR - All
Ping, FTP, Inc. V. 2.11	TCP/IP Interface Address Query	0TR - All
Scanner	Graphic/text Scanner	4TR - N25
SIMPC60	Modem Communication	0TR - Designated Computers
SMERFS V 5.0	Reliability Tool	0TR - All
STATGRAPHIC V. 5.3	Statistic Analysis	0TR - All
STRAD V. 1.02	Strategic Advisor	0TR - All
TELNET, FTP, Inc. V. 2.11	TCP/IP Remote Logon	0TR - All

Software Application Matrix For Room IN-250 Network Screen 2		
Application & Version	**Function**	**Network or Computer**
VIRUSCK	Virus Scan Program	0TR - All
Windows V.3.1	Windows Desktop	0TR - All
WP51 DOS V.5.1	Word Processor	0TR - All
WP6.0 V. 6.0 (WIN)	Word Processor	0TR - DOS

APPENDIX B: SYSTEMS MANAGEMENT COMPUTER LABS RESOURCE GUIDE AND REFERENCE MANUAL

User's Resource Guide and Technical Reference to the Systems Management Computer Lab resources in Ingersoll Hall rooms 224 and 250.

SYSTEMS MANAGEMENT DEPARTMENT
NAVAL POSTGRADUATE SCHOOL
MONTEREY, CALIFORNIA

Computer Labs
IN-224 and IN-250

SM Computer Labs

Resource Guide and Technical Reference

Revised: June 9, 1995

Network Specialist: Mr. Leon Sahlman

Lab Director: Prof. Norman F. Schneidewind

For use in the Systems Management Labs.

TABLE OF CONTENTS

I. Systems Management Computer Lab Overview

This Chapter contains:

- **The Purpose of the Manual**
- **An Overview of the SM Labs**
- **The Organization of the Manual**

A. Introduction

The purpose of this manual is to provide a new user with a brief guide to the resources available on the local area networks (LANs) in the System Management (SM) computer labs located in Ingersoll Hall rooms IN-224 and IN-250. This manual is not a tutorial or training manual and assumes that the user is familiar with basic computer functions and keyboards. The primary user skill level required is a basic skill level with the ability to follow on-line the screen prompt with the appropriate keyboard entries. For specific questions concerning applications on the LANs the user is referred to the individual application's manual which is located within the lab's reference binder.

B. SM Lab Highlights

- **I-158 Software Metrics Lab** - supports a variety of research related to military decision making in the area of software measurement for improving the quality and reliability of DoD software, improving the quality and efficiency of DoD software development and maintenance process. This lab also supports thesis research and student work in LAN studies and LAN connectivity studies.

Network	Servers	User Computers	Remarks
AppleTalk	1 (AP0)	5	LaserWriter Printer
Ethernet (Broadband)	1 (PC1)	3	No Printer
Token Ring	1 (TN4)	6	HP LaserJet 4 / HP PaintJet Color Printer

- **I-224 Networks Systems Lab** - supports group instruction for 1 instructor and 18 users on the Token Ring network and 3 users on the local Ethernet network. This lab supports student instruction in a variety of departmental related courses and provides software resources to students and faculty in support of course assignments, course projects, network studies, and thesis research.

Network	Servers	User Computers	Remarks
Ethernet (Baseband)	1 Dedicated	3	HP DeskJet 500
Token Ring	1 File (TN3) 1 Print (TN6M)	18 + 1 (Instructor)	HP LaserJet III

- **I-250 Decision Support Lab** - supports group instruction for 1 instructor and 25 users on the Token Ring network. This lab supports student instruction in a variety of departmental related courses and provides software resources to students and faculty in support of course assignments, course projects, network studies, and thesis research.

Network	Servers	User Computers	Remarks
Token Ring	1 File (N3) 1 Print (N6)	25 + 1 (Instructor)	HP LaserJet III

C. Organization of Manual

This manual is divided into the following:

I. **System Management Computer Overview** - provides a brief overview of all the SM Labs, giving the location, the purpose, and the networks.

II. **Lab Resource Guide** - Provides the resources available in labs 224 and 250.
- A. Token Ring Resources
- B. Ethernet Resources

III. **Technical Reference to the Labs** - Provides technical information concerning the lab's hardware, topology, and software.

IV. **Appendix -** Provides Standard Lab Forms and Instruction Sheets Used in the Labs.

II. Computer Lab Resource Guide For Rooms 224 & 250

This Chapter contains:

- **Token Ring Resources in Rooms 224 and 250**
- **Ethernet Baseband Resources in Room 224**

A. Token Ring

Shared Token Ring Application Resources

The Token Ring network provides a variety of applications from which the user may choose. These applications may be DOS or Windows and may be executed in either room 224 or 250 if the user computer has the appropriate hardware. The next section discusses some shared resources including the various software applications available on the Token Ring network.

Applications: The software applications on the token ring network are maintained on 2 different servers (TN3 in 224 and N3 in 250) which are similar. Each server supports the room in which it is located. If a server goes down in one room, the same application will be available on the server in the other room.

Printers: The printers on the token ring are connected to print servers located in the same room (TN6M in 224 and N6 in 250). The software configuration forces the printouts to the same room that the user computer is located.

Windows: The Windows applications are installed to provide a "standard look" to the users when viewing the Program Manager as shown in Figure 1. The specific applications will change over time as their utilization changes and the course requirements for SM lab software changes.

1. Shared Windows Application Resources

A "standard " Windows screen display is provided to the users at logon. It is the goal of the Lab staff to present the same "standard" display in both rooms 224 and 250 as shown in Figure 1.

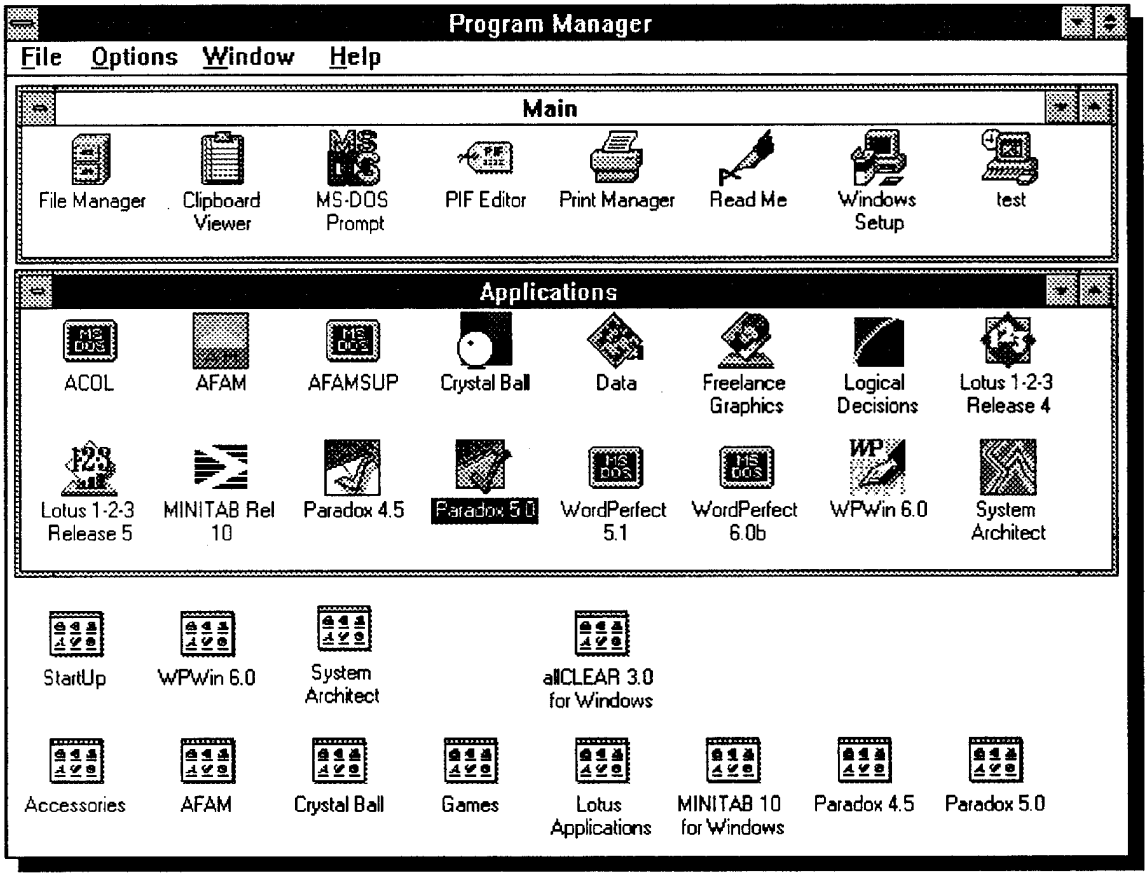


Figure 1 Token Ring Standard Windows Desktop.

2. Application Matrix

All computers in the labs use a file manager named 1DIRPLUS to manage the files, change directories, and execute programs (Figure 2). The following matrices display the files in the same sequence as the file manager. The following pages provide the room layout and the associated application matrices for each of the rooms, 224 and 250.

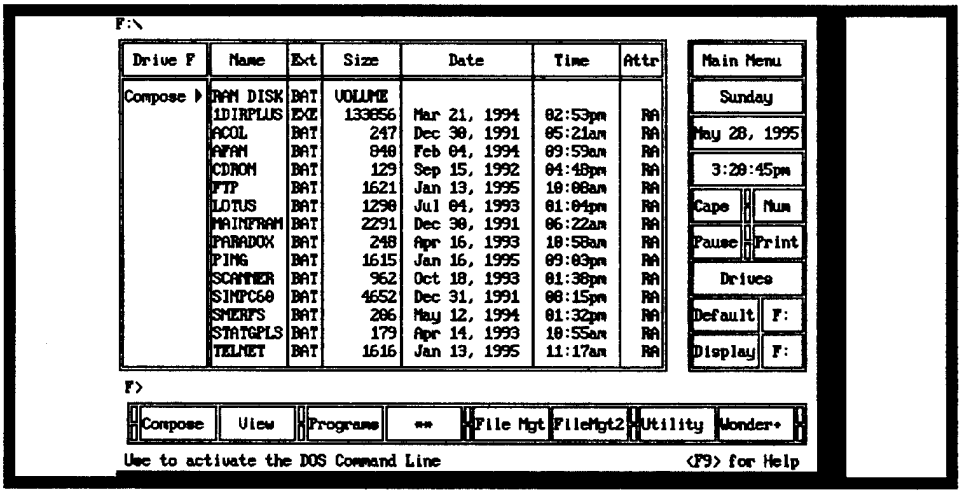


Figure 2 A Typical 1DIRPLUS File Manager Screen.

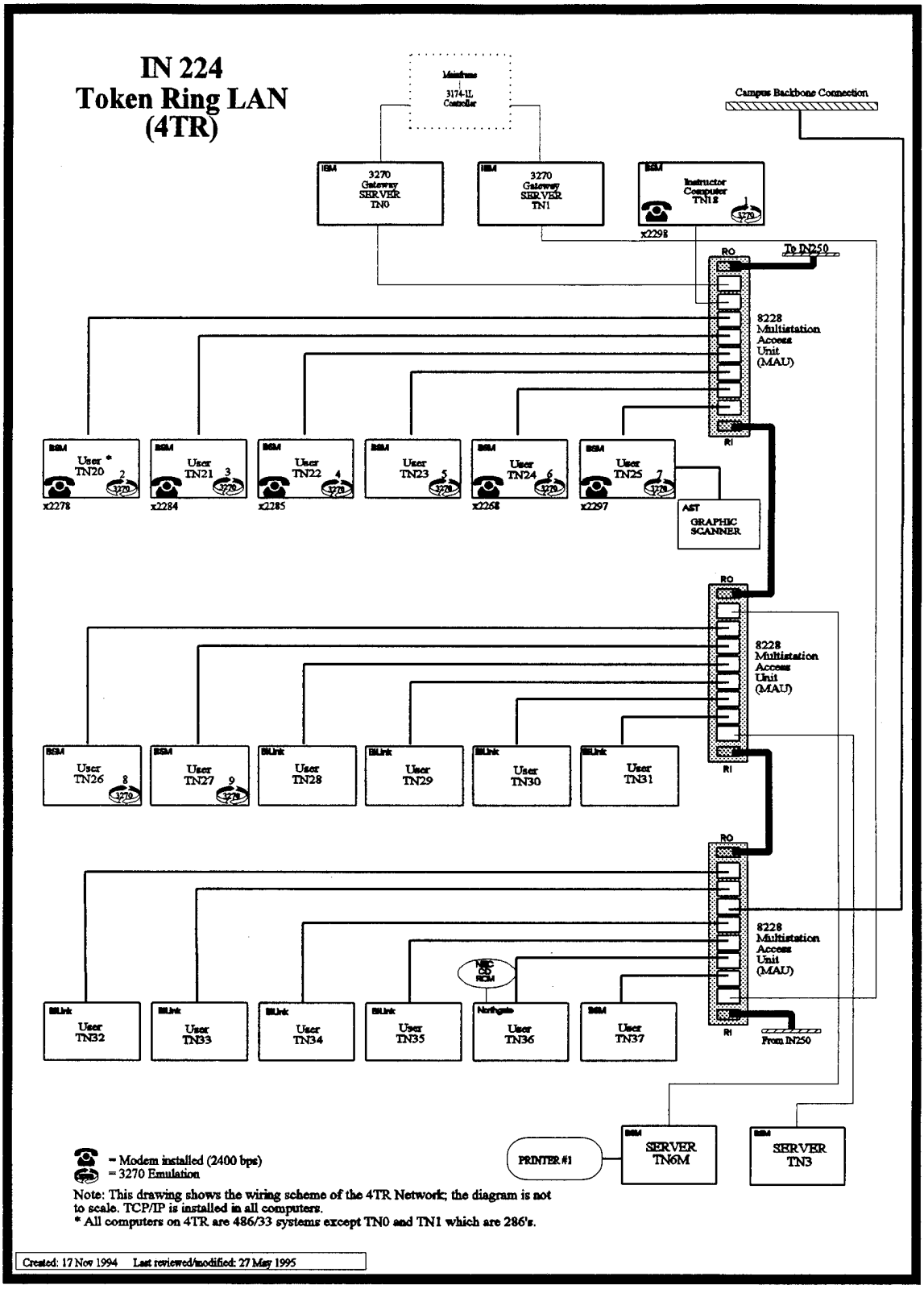


Figure 3 Token Ring Room IN-224.

a. Applications Matrix For Room 224

Software Application Matrix For Room I-224 Networks Screen 1		
Application & Version	**Function**	**Network or Computer**
1DirPlus V.3.0.2	File Manager	4TR & 4EN All
ACOL V.1.0	Costing Model	4TR - All
AFM V 1.4	Air Force Acquisition Model Supplement	4TR - All
CD ROM	Read Only Optical Device	4TR - TN36
FTP, FTP,Inc. V. 2.11	File Transfer	4TR - All
LOTUS 1-2-3 DOS V.2.3	Spreadsheet	4TR - All
Mainframe IBM PC 3270 Emulation V.3.03	3270 Mainframe Terminal Emulator	4TR - Designated Computers
Paradox V 4.0	Relational Database	4TR - All
Ping, FTP, Inc. V.2.11	TCP/IP Internet Address Query	4TR & 4EN - All
Scanner AST EyeStar V. 1.35	Graphic/text Scanner	4TR - TN25
SIMPC60	Modem Communication	4TR - Designated Computers
SMERFS V 5.0	Reliability Tool	4TR - All
STATGRAPHIC V. 5.3	Statistical Analysis Tool	4TR - All
TELNET, FTP, Inc. V. 2.11	TCP/IP Remote Logon	4TR - All

Software Application Matrix For Room I-224 Networks Screen 2		
Windows V.3.1	Windows Desktop	4TR - All
WP51 DOS V. 5.1	Word Processor	4TR - All

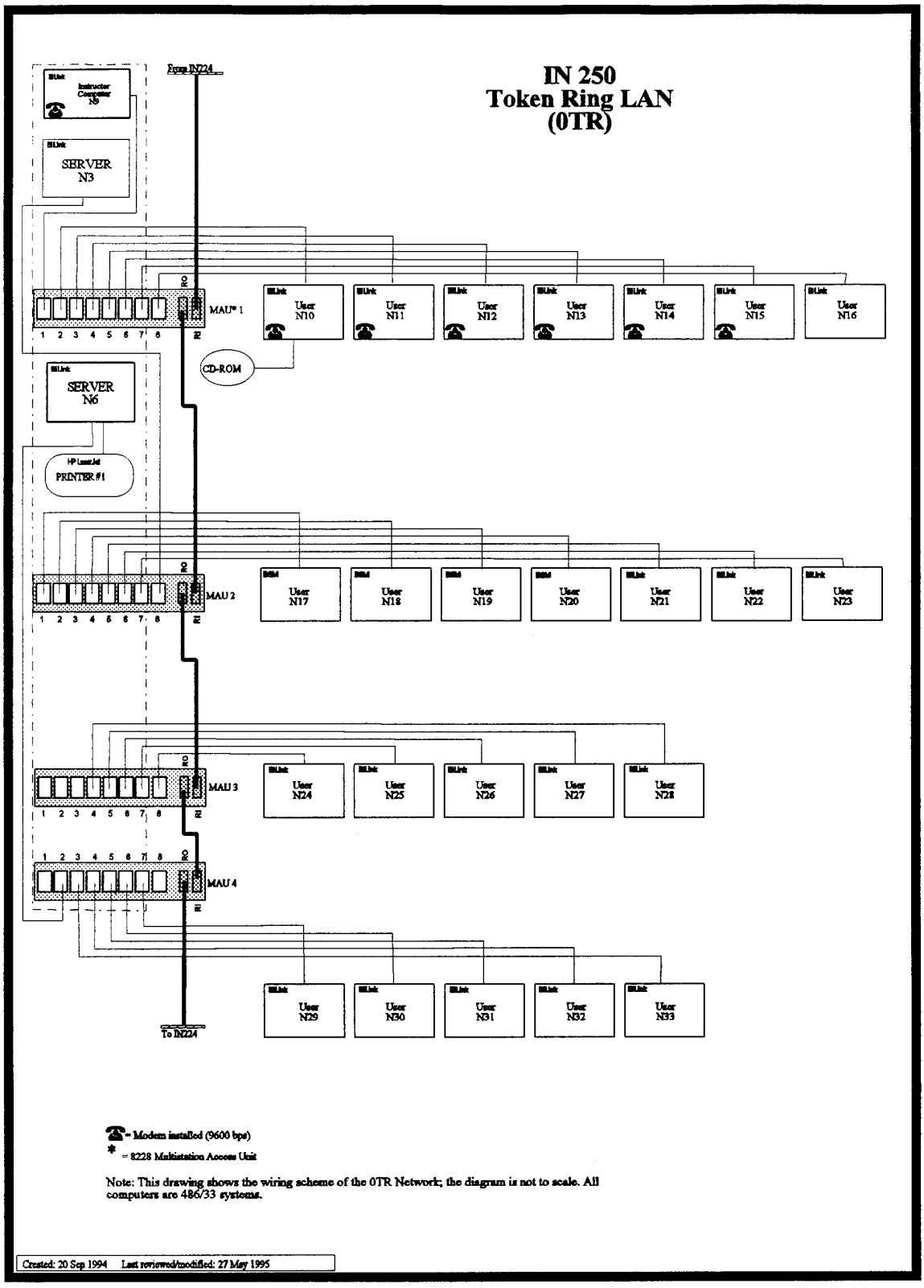


Figure 4 Token Ring Network in Room 250.

b. Applications Matrix For Room 250

Software Application Matrix For Room IN-250 Network Screen 1		
Application & Version	**Function**	**Network or Computer**
1DirPlus V.3.0.2	File Manager	0TR - All
ACOL V.1.0	Costing Model	0TR - All
AFM V 1.4	Air Force Acquisition Model Supplement	0TR - All
CD ROM	Read Only Optical Device	0TR - N10 (Only computer)
CRITERUM	Decision Support Model	0TR - All
FTP, FTP, Inc. V. 2.11	File Transfer	0TR - All
LOTUS 1-2-3, DOS V. 2.3	Spreadsheet	0TR - All
Mainframe, IBM PC 3270 Emulation V. 3.03	3270 Mainframe Terminal Emulator	4TR - Designated Computers
Paradox V. 4.0 (WIN)	Relational Database	0TR - All
Ping, FTP, Inc. V. 2.11	TCP/IP Interface Address Query	0TR - All
Scanner	Graphic/text Scanner	4TR - N25
SIMPC60	Modem Communication	0TR - Designated Computers
SMERFS V 5.0	Reliability Tool	0TR - All
STATGRAPHIC V. 5.3	Statistic Analysis	0TR - All
STRAD V. 1.02	Strategic Advisor	0TR - All
TELNET, FTP, Inc. V. 2.11	TCP/IP Remote Logon	0TR - All

Software Application Matrix For Room IN-250 Network Screen 2		
VIRUSCK (Current)	Virus Scan Program	0TR - All
Windows V.3.1	Windows Desktop	0TR - All
WP51 V. 5.1	Word Processor	0TR - All
WP6.0 V.6.0	Word Processor	0TR - All

3. Additional Resources

These are additional lab resources which provide additional capabilities to the users. These resources include both hardware and software and are listed in the following:

Mainframe Communications

Modem Access: Simpc is the communication software that allows access to the mainframe computer using the computer's internal modem and the local telephone line. Significant facts include:

- Transfer rate is limited to the 2400 BPS of the internal modem.
- Room 224 - available on TN18, TN20, TN21, TN22, TN24, TN25, TN26, AND TN27.
- Room 250 - available on N9, N10, N11, N12, N13, N14, AND N15.
- Only works if Simpc is installed on both ends of the connection.

Terminal Emulation: IBM 3270 Emulation is only available in room 224 and allows 9 computers to access the mainframe. The software re-maps the PC's keyboard to the keyboard of a 3278/3279 terminal. Sheets depicting the re-mapped keys are available in room 224. Basic features are:

- Transfer rate is extremely fast due to the direct coaxial connection to the mainframe via a gateway server.
- Keyboard is automatically re-mapped during session.

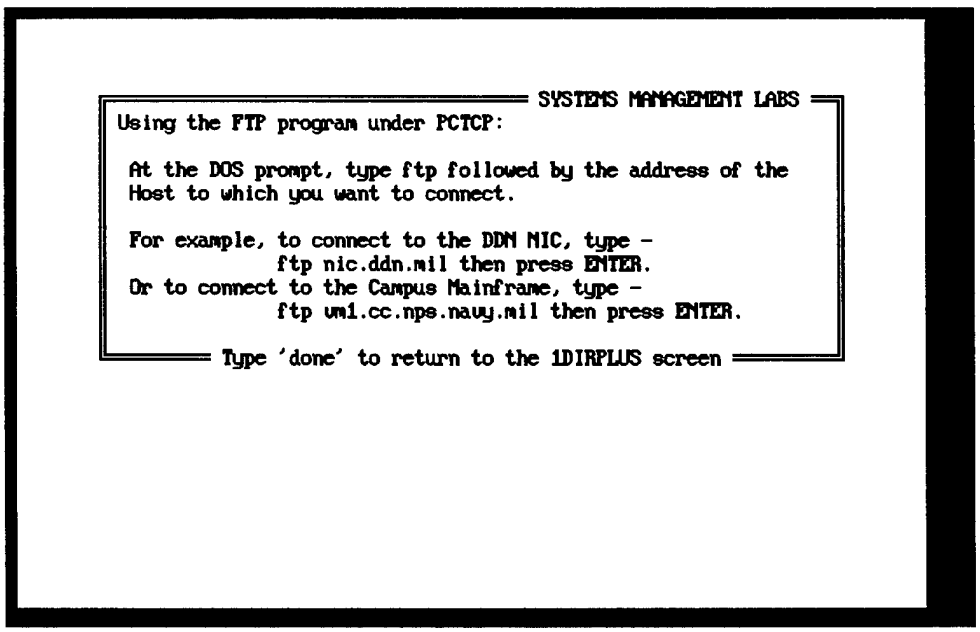
- Data can be saved to disk on the PC.
- Only available in room 224 on computers TN18, TN20, TN21, TN22, TN23, TN24, TN25, TN26, and TN27.

TCP/IP:

All users' computers in rooms 224 and 250 have TCP/IP capability. This protocol allows a suite of TCP/IP applications to operate which includes E-mail, FTP (File Transfer), Ping (a host connectivity check), and TELNET (Remote logon). TCP/IP allows connectivity to the following:

- Connection to the mainframe.
- Connection to the Sun Workstation.
- Connection to any TCP/IP capable machine via the campus backbone or internet.

A typical on-line TCP/IP user screen:



Other Resources

CD ROM:

External CD ROM readers are available in room 224 and 250. Each reader requires a CD ROM carrier to hold the disk and cannot be operated without it. Carriers can be obtained from the lab staff in room 331A. CD ROM instructions (Appendix) are available in each of the rooms on the rack by the door.

- **Room 224:** CD ROM is connected to computer TN36.
- **Room 250:** CD ROM is connected to computer N10.

Graphics Scanner:
(Room 224 Only)

An AST Graphic Scanner is available in 224 for student use. Each sheet to be scanned must be hand fed into the scanner and allowed to be pulled through one sheet at a time. The program is DOS based and menu driven. It allows the choice of several file types to the user. Additional information is located in the reference binder with the other user manuals.

Video Projector:

Both rooms 224 and 250 have a ceiling mounted video projection system installed. The video input is taken from the instructor's computer and projected in the front of the lab. This equipment facilitates group instruction while providing excellent visibility to all the user computers.

B. Ethernet Baseband Network

The Ethernet baseband network is only available in room 224 and contains its own unique set of applications and hardware. The following matrix shows the Ethernet software matrix:

Ethernet Software

The following matrix appears on the 3COM EtherSeries network:

Software Application Matrix For Room I-224 3COM EtherSeries Ethernet Screen 1		
Application & Version	**Function**	**Network or Computer**
!Wonder V. 3.02	File manager	3COM network, ENET1 - ENET3
DBase Aston-Tate V.4.1	Relational Database Program	3COM network, ENET1 - ENET3
Email EtherSeries V. 2.4	Email Application	3COM network, ENET1 - ENET3
Eprint EtherSeries V. 2.5	Print Program	3COM network, ENET1 - ENET3
FTP FTP, Inc. V. 2.11	File Transfer	3COM network, ENET1 - ENET3
Help EtherSeries V. 3.4	On-line Help File	3COM network, ENET1 - ENET3
Logout EtherSeries V. 3.4	Exits the Ethernet	3COM network, ENET1 - ENET3

Applications continue on the following page.

Software Application Matrix For Room I-224 3COM EtherSeries Ethernet Screen 2		
Application & Version	**Function**	**Network or Computer**
Ping FTP, Inc. V. 2.11	TCP/IP Internet Address Query	3COM network, ENET1 - ENET3
SGPLUS V. 5.3	Statistical Analysis Tool	3COM network, ENET1 - ENET3
SMERFS V. 5.0	Reliability Tool	3COM network, ENET1 - ENET3
Storyboard V.1.1	Graphics Utility	3COM network, ENET1 - ENET3
TELNET FTP, Inc V. 2.11	TCP/IP Remote Logon	3COM network, ENET1 - ENET3
Virusck McAfee V. 5.5	Virus Scann Utility	3COM network, ENET1 - ENET3
WP51 DOS V. 5.1	Word Processor	3COM network, ENET1 - ENET3

Ethernet Hardware

The Ethernet LAN is a 3COM EtherSeries ethernet LAN. It consists of 4 PCs, a 3COM server, a Multiport Repeater, and a HP DeskJet 500 printer. There are no additional hardware units attached to the 3COM Ethernet. A complete description of the hardware is given in Chapter III and in the 3COM User's Manual located in the reference binder with the other manuals .

III. Technical Reference

A. Labs 224 And 250 Overview

Lab 224, the Networks Systems lab, contains two LANs, a token ring and an Ethernet. The largest LAN in room 224 is an IBM Token Ring (TR) network and is designated by (4TR), which is a combination of the room number and the LAN type. 4TR is physically and logically connected to room 250 via the Token Ring (Figure 6), the mainframe via a direct 2370 emulation connection and modems using Simpc, and the Campus backbone using TCP/IP. This room has 23 computers on the TR network and they are labeled between TN0 and TN37.

In 224, all "TN" computers are 486/33 systems except TN0 and TN1. These two computers are 286 systems located in the front of the room and serve as gateways to the mainframe. The two TR servers located in the back of the room are TN3 and TN6N. TN3 is a file server and TN6N is a print server for an HP laser printer located in the back of the room. Lab users may use any of the TN user computers for network access except the four special purpose computers, TN0, TN1, TN3, and TN6N (See Figure 3).

Lab 250, the Decision Support lab, contains only the token ring network and is designated as (0TR). This network is an extension of the token ring in rooms 158 and 224. The computers in this room have an "N" designation and are labeled N9 - N33. 0TR is able to access the mainframe via modem using Simpc. Modems are installed on computers N9 - N15. There are 25 user computers and 2 servers. The file server is N3 and the print server is N6.

B. Token Ring

Network Highlights:

- IBM PC LAN Version 1.21
- Connects Rooms IN-158, IN-224, and IN-250 via Token Ring
- Supports 19 users in room IN-224
- Supports 25 users in room IN-250
- Operates at 16 MBPS
- Supports TCP/IP Protocols

1. Hardware And Topology

The token ring network is the largest network in the SM labs. This network physically connects the three SM labs in rooms 158, 224, and 250. (See Figure 6) The token ring protocol, based on the IEEE 802.5 standard, uses managed network access and requires the computers on a network to possess an electronic token before transmitting. This token is passed around the network's logical ring and allows each network computer an opportunity to transmit. Because of the managed access protocol, each computer has an equal opportunity to access the network. This provides a significant speed advantage to the token ring when a large number of users

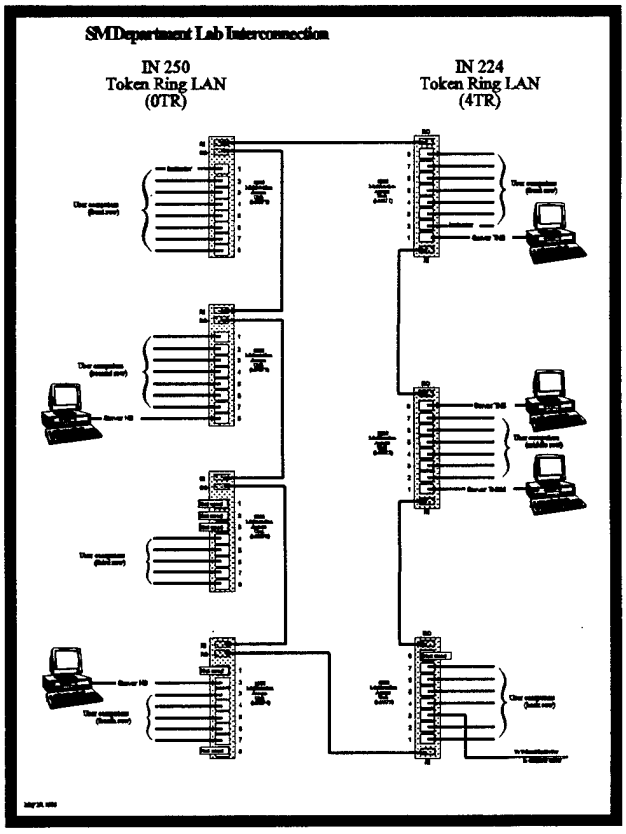


Figure 6 Token Ring Lab Connectivity Rooms 224 and 250.

are on the network because there is no time lost resolving the collisions that occur when two computers try to transmit at the same time. Collisions will be discussed in the Ethernet baseband section.

The basic hardware components of the token ring network are the IBM compatible personal computers (PCs), the computer network board, the network cables, and the Multistation Access Unit (MAU). PCs have two functions on this network, a server PC and a user/client PC. The servers are dedicated to file servers and promote server functions. This requires the server computers to be restricted to network use only and not be allowed to be used as a user computer. The server keyboards are kept locked with placards placed on each server to identify it as a server. If the keyboards were allowed to be used, the keyboard inputs would have priority over the server's network functions. This would slow the response time of the network.

Additional hardware may be installed in the various computers to support their functions on the network. For example, a file server may have a larger hard drive or other storage device to accommodate the storage of a large amount of information. All lab computers are configured with eight megabytes of RAM. Additional devices may also be included on the user PCs such as modems, CD ROM drives, or scanners. All PCs will have network interface boards installed to allow connection to the network.

The token ring network has a file server and a printer server in each room. The file servers are each configured to store network programs, utility programs, and user applications. The directories and files on the server's hard drive are configured for read only access. This is achieved through a combination of network operating system (NOS) commands and DOS attribute commands. Network commands allow assigning read, write, or create attributes to the directories. The DOS attribute command can assign read only attributes to files to protect them from changes and alterations by users. The servers have RAM drives that provide improved network performance by avoiding the mechanical delays encountered when searching the hard drives for data. One RAM drive contains the application batch files which are used by the user computers to access applications. A second RAM drive contains network related files that the server requires during network operations.

Files are copied to these RAM drives during the server start and remain available in the RAM drive during the server's operation.

Servers provide both file and print service. While managing the network printing functions, the print server receives a print request or print job from a user computer and stores the job until the printer is available. When the printer is available to print, the print server then forwards the job to the printer. All print requests are handled on a first in, first out (FIFO) basis.

The token ring network is a physical star and logical ring network. The physical star is implemented with the Multistation Access Unit (MAU). Each MAU has ten total connections, eight are computer connections, and two are ring in, ring out, connections that allow the MAU to be inserted into the network. The MAU serves as a hub for the various computers along a network and provides bypass circuitry and fault sensing for the network. This provides increased network reliability, and ease of adding (or removing) a computer to the network. Using the ring in and ring out connections, a MAU can extend the number of computers on the network by inserting an additional MAU. These connections also allow the network to span several rooms or floors by using extended length cables.

The media used in this network is "data grade" cable. This cable is composed of shielded, twisted pair wire, with two of the twisted pairs within the shielding. The extra pair provides an additional linkage for backup and the shielding provides improved data flow by minimizing the effect of electromagnetic interference from the local environment. IBM manufactures seven types of cables for use in token ring networks. There are four shielded cables, two unshielded cables, and one optical-fiber cable. (Feibel, pp. 155-156) The cables are used to connect the computer network boards to the MAUs and to connect the MAUs.

2. Other Resources

These resources are located in the labs indicated:

Gateways: The lab in room 224 has two dedicated "286" PCs that function as a gateway or link to the mainframe computer. These gateways allow nine of the user PCs in this lab to logon to the mainframe using 3270 emulation. 3270 emulation provides the fastest data transfer of any method available in the lab.

Internal modems: These are installed in rooms 224 and 250. These modems use the Simpc program to dial the school's computer center and logon to a mainframe or Unix account at 2400 BPS. The computer center is the only menu item listed in the program because the Simpc program requires Simpc to be used at both ends of the modem connection. The phone lines are also blocked to allow only local calls on campus. There are six modem equipped PCs in room 224 and seven in room 250.

TCP/IP: TCP/IP is installed on all computers in rooms 224 and 250. This protocol provides communication with other TCP/IP computers on the Campus Backbone and on the internet via the following:

Token Ring: The MAU in room 224 is connected to the CISCO router in the computer center which connects to the Campus Backbone.

3COM Ethernet: The Multiport Repeater connects directly to the Campus Backbone using an AUI cable and Transceiver.

Scanner: An AST Graphic Scanner is located in room 224. This scanner is connected to one of the user computers and allows the scanning of graphic images into electronic form. The required scanning software program is installed on the individual PC.

CD ROM: Two external CD ROMs are connected to user computers on the network. One is in room 224 on TN36 and the other is in room 250 on N10. These external CD ROMs allow the reading of optical disks using the software installed locally on the PC. In both rooms, 224 and 250, the CD ROM is designated as the "E" drive on the computer and requires the use of a CD carrier to hold the CD disk. This carrier may be obtained from the lab staff in room 331A. Instruction sheets are maintained in the labs see Appendix.

Video Projector: Both rooms 224 and 250 have a ceiling mounted video projection system installed. The video input is from the instructor computer located in the front of each lab. This system is useful for class demonstrations, group instruction, and provides excellent visibility to the users seated at their user computers.

3. Network Software

The network software that is common to all token rings includes the network operating system (NOS), the LAN support programs, the PC's Disk Operating System (DOS), and a memory management program. IBM's PC LAN Program Version 1.21 is the NOS used on our token ring network. The kernel of the NOS manages the network and must be resident in the memory of both the server and the user computers for the network to operate. The MS DOS Version 5.0 is the operating system for the PCs and must always be installed before a PC can be used.

The LAN Support Program consists of drivers that provide for the physical and data link layers of the IEEE 802.5 standard. These drivers are at the lower layers of the network architecture and are independent of the type of network.

QEMM is the memory manager used in the PCs in the labs. It provides the memory management that allows the drivers to be successfully loaded and operate within a computer's limited conventional memory. Memory management is a crucial component of any computer system and this is especially true if the computer is attached to a network. Due to the early

design architecture of the PC, a limitation of 1 MB of addressable memory has been inherited by our current PCs when operating under DOS (See Figure 7).

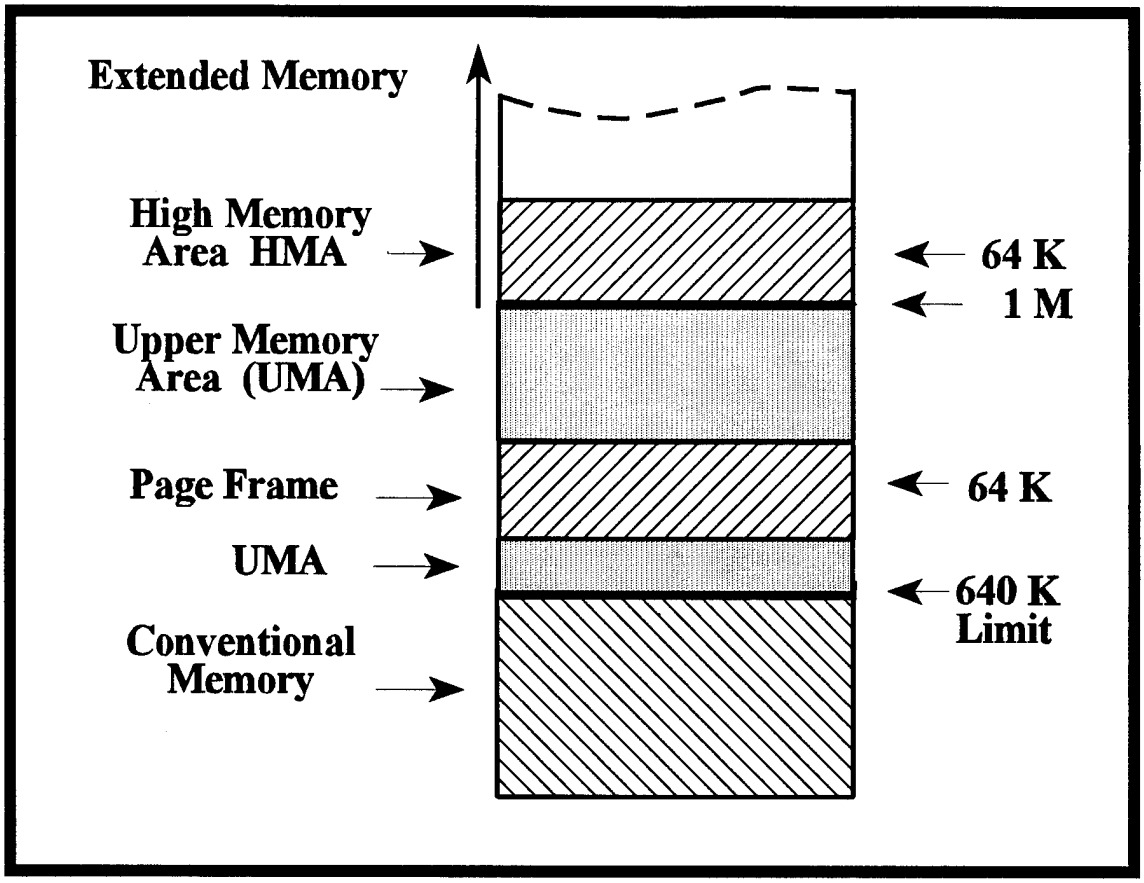


Figure 7 Typical PC Memory Representation (Schneidewind, 1995).

Within the 1 MB of addressable memory, only the first 640 KB was available to execute programs. The term "640 KB Barrier" is used to describe this limitation. The area from 640 KB to 1 MB is used to map system ROMs, memory-mapped I/O devices, and device drivers. For additional information see (Goodman, pp. 45-47).

The software controlling the network configuration and logon process consists of batch files written to prompt the user for a "START" command followed by a logon name. During the computer boot process, the autoexec.bat and config.sys files configure the system to the proper network parameters and assign the appropriate file server and print server

depending on the computer's room location. The configuration process also determines the computer's capabilities through the use of variable parameters. This sets the configuration for functions such as modem or 3270 emulations.

Many user applications are stored on the server in protected read only files and are then copied to the user's computer when called by a user's batch file. A few software application and programs are loaded directly onto the user's computer and not on the server. These exceptions are a result of program incompatibility problems or very slow response times. For some programs, like Windows, user access would be too slow with the program installed on the server. Other applications, like Statgraphics, there are compatibility problems using a server and it will only run from the user PC. For a listing of the available Token Ring applications see Chapter II.

C. Ethernet Baseband

Network Highlights:

- Located only in room 224.
- 3COM EtherSeries Version 2.4
- Supports 3 user PCs with applications from the 3COM server
- Supports 1 PC as a FTP file server
- Operates at 10 MBPS
- Supports TCP/IP Protocols
- Connects to the campus backbone via an AUI cable from the Multiport Repeater

The Ethernet baseband is the second network in room 224. This network is a 3COM Ethernet LAN (Figure 8) and is designated (4EN). There are 4 computers on this network and are identified as ENET1 - ENET4. These computers are both physically and logically connected to the Campus Backbone via a Cabletron Ethernet Repeater using TCP/IP. The 3COM server is attached to an HP DeskJet 500 printer to provide print capability to this

network. Ethernet user computers ENET1 through ENET3 are logically attached to the 3COM server and have full access to the network applications and printer. ENET4 is a dedicated FTP file server and is physically but not logically connected to the 3COM server. ENET4 can only execute programs stored internally on its hard drive and does not have access to the applications on the 3COM network.

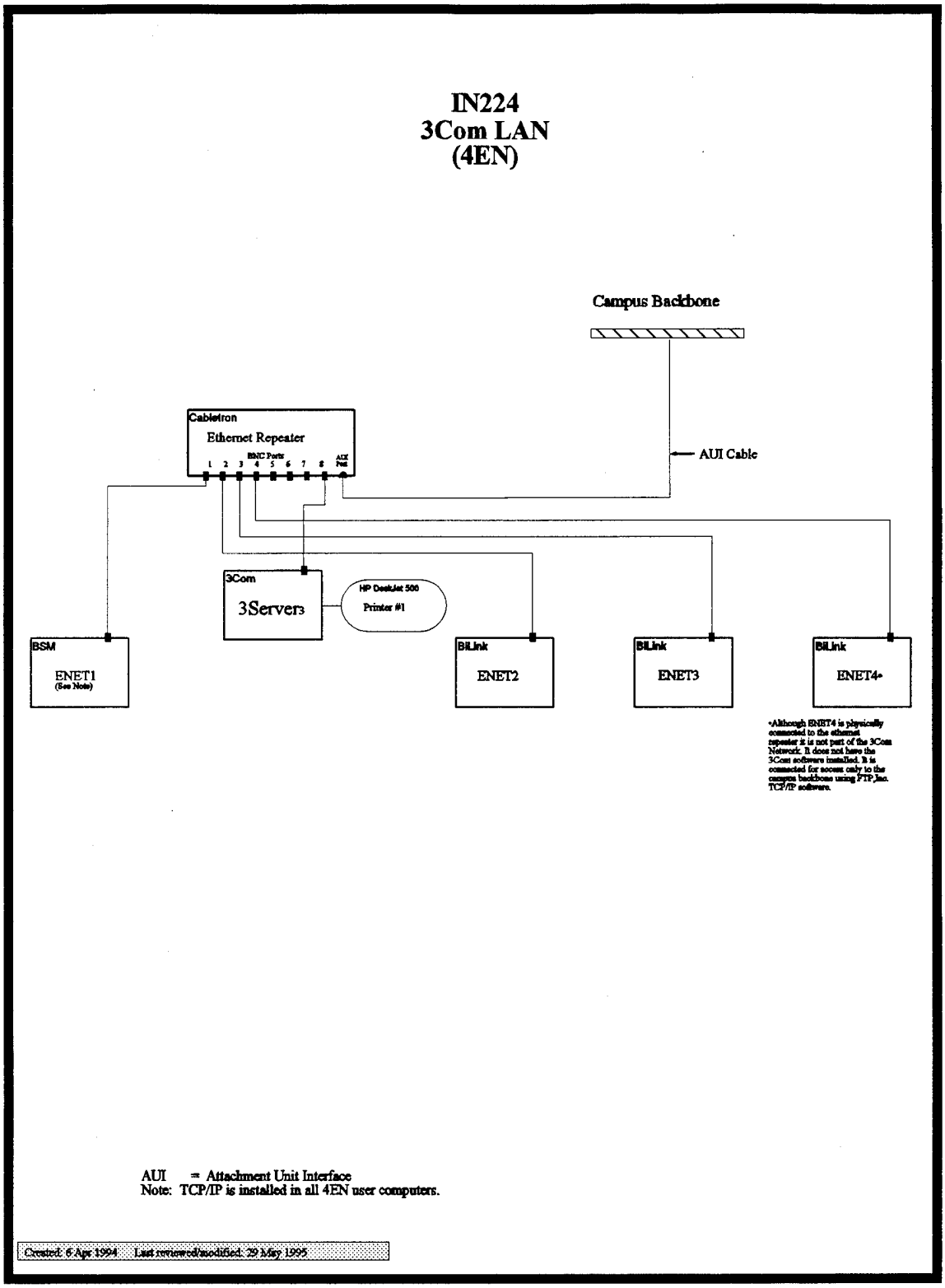


Figure 8 3COM Baseband Ethernet in Room 224.

1. Baseband And Broadband Differences

The SM labs have two types of Ethernet LANs which are very different in design, hardware, and topology. The baseband Ethernet located in room 224 uses a broadcast method of transporting messages along the network. The Broadband Ethernet located in room 158 uses a translator unit to broadcast its messages along the network in two different frequencies.

Although these networks are different in hardware and topology, both use the Ethernet IEEE 802.3 protocol of Carrier Sensing Multiple Access/Collision Detection (CSMA/DC). Unlike the token ring's IEEE 802.5 protocol of managed network access, the Ethernet protocol is a contention system and all transmissions are broadcast over a logical buss. The CSMA portion of this protocol requires the transmitting computer (sender) to listen to the network to detect a carrier signal. If no transmissions are heard, the computer begins to transmit a message while continuing to listen. If two computers transmit at the same time, the computers would detect a collision (non-normal signal) on the line. After the collision detection (CD), the computers would transmit a "jam" signal to advise other computers that there has been a collision. Each computer uses an exponential backoff algorithm for determining how much time a computer must wait before retransmission is attempted. If another collision occurs on the subsequent transmission attempt, the delay time is doubled.

2. Baseband Characteristics

The performance of an Ethernet baseband LAN is good for low to moderate traffic. Heavy traffic can slow a network's response time as computers compete to access the network. The extreme case is when the Ethernet traffic reaches or approaches saturation. This is called an Ethernet meltdown and results in repeated transmission attempts by the network computers. (Feibel, p. 364) Saturation or meltdown is not possible with token ring managed access. As the number of computers increases on an Ethernet LAN or the distances between computers increase, the probabilities of collisions also increase. For a successful Ethernet transmission, the signal propagation delay must be less than or equal to the

transmission time. As the cable length increases, the transmission speed (BPS) must decrease to keep an equivalent ratio because the packet size and the propagation speed are usually constant. The parameters for the formula are given in Equation 1.

$$(\text{Round Trip}) \quad \frac{\text{Cable length}}{\text{Propagation Speed}} \leq \frac{\text{Packet Size}}{\text{BPS}}$$

- Cable length = twice cable length in meters
- Propagation Speed = Speed of signal in medium in meters per second
- Packet size = in bits
- BPS = transmission speed of the network in bits per second

Equation 1 Ethernet Transmission Formula

Because Ethernet protocol is not managed access, excessive delays could result if the network has a large number of users or the number of messages are high. These factors may result in transmission rates that are much slower than those advertised by the manufacturer.

a. Hardware And Topology

The baseband Ethernet in room 224 is a thin net 3COM EtherSeries. The shielded RG58 thin net Ethernet cables are rated at 50 ohms and all the required interface circuitry is contained within the network interface card (NIC) which is installed in the computer. The hardware requirements for this network include the IBM compatible PCs, the EtherLink cards (NICs), coaxial cable, BNC T-adapters, Transceiver cables and terminators. For an in depth discussion of these components see (Anderson, p. 14 -15). The server for the 3COM EtherSeries is a 3COM 3Server3 which is not a PC. It differs from the other servers in the room in that it does not have a keyboard or monitor and was specifically designed for use as an Ethernet server.

Ethernet LANs are always a logical bus but their physical topology may be either a bus or a star. The 224 Ethernet (4EN) is a physical star that uses a Cabletron Multiport Repeater as the hub. The advantages of using a multiport repeater include having a cleaner, stronger signal on the bus, extended network operating range as a result of the stronger signal, fault isolation capability as a result of the repeater's auto-partitioning, and the ability to interface with the school's thick Ethernet back bone. The repeater connects to the thick net through the attachment unit interface (AUI) cable. This cable runs from the repeater to a transceiver which is attached to the thick Ethernet cable. Thick Ethernet requires the use of a transceiver that contains the circuitry required to perform the CSMA/CD functions. For additional information on the AUI see (Feibel, p. 206).

The 3COM Ethernet (4EN) has four computers and one server attached to the multiport repeater. The server is also attached to a HP DeskJet 500 printer. Three of the computers, ENET1 - ENET3, are both physically and logically attached to the network. The fourth computer, ENET4, is physically but not logically attached to the Ethernet. See Figure (8) for the network configuration.

b. Software

The ENET1 - ENET3 PCs are user computers on the 3COM Ethernet. All three contain the user software required to access the server's applications. The 3COM server provides both user applications and print capability. The fourth PC, ENET4, is effectively a stand-alone computer and has access only to the software stored on its internal hard drive. ENET4 uses the multiport repeater to access the campus backbone using TCP/IP, but it cannot access the Ethernet or the printer. ENET4 is configured as a TCP/IP server and is able to store and receive files. This configuration prevents it from being used as a user computer.

All four 3COM Ethernet computers have TCP/IP installed. The three Ethernet computers use IBM TCP/IP software. ENET4 uses TCP/IP software manufactured by FTP Inc. A listing of the 3COM software is provided in Chapter II and a user's manual (Anderson, p. 24 - 49) with a step by step guide to the 3COM system in maintained in the lab's reference

binder.

LIST OF REFERENCES

Anderson, D. L., *3COM EtherSeries Local Area Network,* Masters Thesis, Naval Postgraduate School, Monterey, CA., 1989.

Feibel, W., *Novell's Complete Encyclopedia of Networking,* Novell Press, 1995.

Goodman, J. M., *Memory Management For All Of Us*, Sams Publishing, 1992.

Schneidewind, N. F., *IS 3503 Microcomputer Local Area Networks Class Notes,* Winter Quarter, NPS Monterey, CA., 1995.

APPENDIX

Standard SM Lab Forms and Instructions used to communicate with the users.

<< USING THE CD-ROM READER >>

NOTE: THE CD-ROM READERS ARE ATTACHED TO COMPUTERS TN6 IN ROOM 158, TN36 IN ROOM 224, AND N10 IN ROOM 250.

A. BEFORE USING THE CD-ROM READER, OBTAIN A CD CARRIER. A limited number of carriers are available for loan from the Lab Staff in Room 331A.

B. Start the user computer on the network using the start up instructions provided.

1. Select *CDROM.BAT* in the Batch File Directory (Drive F:) and press [ENTER].

2. When the CD-ROM Reader has been configured a message will be displayed that indicates the drive letter that has been assigned to the reader and that it is ready for use.

C. Insert the CD into the carrier so that its label is facing up. Press the two corners at the front of the carrier to open the lid. Insert the CD by tilting it slightly in the direction of the arrow (⌓). Press the two corners of the lid until you hear it snap.

D. Hold the carrier (with the CD label facing up) so that the arrow (⌓) is pointing toward the CD-ROM Reader. Insert the carrier into the slot in the front of the reader. Push the carrier into the reader until it snaps into position (or the reader takes hold of the carrier).

E. After a few moments the CD will be ready for access. At the computer, change from the Batch File Directory to the Drive (usually E:) that was assigned to the reader. The screen will display the directories and files on the CD in the same manner as any other drive or diskette.

F: To remove the carrier and CD press the *Eject* button on the front of the reader. It is also possible with some applications to eject the carrier and CD using a command from within the application.

NOTE: CD ROMs VARY FROM ONE VENDOR TO ANOTHER WITH REGARD TO HOW THEY CAN BE ACCESSED. BE SURE TO THOROUGHLY REVIEW THE DOCUMENTATION THAT COMES WITH YOUR CD TO DETERMINE HOW IT IS INSTALLED AND WHETHER OR NOT IT WILL OPERATE PROPERLY IN A NETWORK ENVIRONMENT.

<< VIRUS CHECK >>

March 3, 1994

TO SCAN FOR VIRUSES:

1. Select the VIRUSCK.BAT program on the F: Drive and press <ENTER>.
2. Insert the suspected diskette into the appropriate drive.
3. At the F:\[Type VSDONE to return...] prompt, type SCAN d: <ENTER>
   (where d: is the drive you are checking).
4. If the scan program reports an infection, make a note of the virus name found in the square brackets, ie [Form], then continue to Step 4(a). Otherwise, go to Step 5.*
   a. TURN OFF THE POWER TO THE COMPUTER for at least 20 seconds.
      Turning off the computer will prevent any further infection from the virus. If, while rebooting the computer, the VSHIELD program (which executes during the bootup process) reports that the computer's hard disk has an infection, please report this to the Lab Staff or the Department Secretary right away and then use another computer to continue. At the second computer, be sure that the second computer does not report a virus when it starts up. To avoid possible infection of the second computer, DO NOT DO ANY OTHER PROCEDURES OR RUN ANY OTHER APPLICATIONS WHILE AN INFECTED DISKETTE IS IN THE FLOPPY DRIVE. This will help prevent the virus from spreading to a diskette in the other floppy drive or the system's hard drive. Go to Step 4(c).
   b. If you have not changed computers, remove the diskette, then turn the system back on.
   c. Start the computer on the network.
   d. At the Batch File directory (Drive F:) select VIRUSCK.BAT.
   e. Go immediately to Step 6.
   IMPORTANT: DO NOT USE THE INFECTED DISKETTE ON THIS COMPUTER AND DO NOT DO ANY OTHER PROCEDURE BEFORE CLEANING THE VIRUS FROM THE DISKETTE!
5. If the scan program does not report any virus infections, it is safe to continue using your diskette.
   a. Type VSDONE to return to the Batch File directory. (This command will reset the system so it is ready for selecting another program.)

TO REMOVE A VIRUS:

6. At the F:\[Type VSDONE to return...] prompt, type CLEAN d: [*virus name*] <ENTER>
   (where d: is the drive that contains the infected diskette and the virus name is immediately preceded and followed by the square brackets).
7. SCAN the diskette again for any other viruses by following Steps 1-4 again.
   (The virus program detects and cleans only one virus at a time.)

The CLEAN program will try to remove the virus. If the cleaning is successful then your diskette will be safe to use again. If the CLEAN program reports that it is unsafe to remove the virus, it means that the vital information areas of the diskette would probably become corrupted during the cleaning process (if they are not already corrupted). It also means that the files on the diskette are unrecoverable with the scanning and cleaning programs in the lab. You will probably need to use the backup copy of your file. The diskette itself can be saved by reformatting it but all files will be lost. It might be possible to recover files on an infected diskette by using a file recovery utility, but that capability is not available in the labs.

* When the screen displays More? (H = Help) you may strike h to get a brief list of keystrokes you can use. If you wish to continue scanning or to exit just press n to return to the F:\[Type VSDONE to return...] prompt.

SM LABORATORY SUGGESTION FORM

Users, please complete items 1-5 below.

1. Date:	2. Name:	3. Phone:
4. Faculty Code or SGC #:		

5. Suggestion: (Please include the reasons for your suggestion and the benefits that will result from implementing it.)

For Use of Lab Staff Only

6. Suggestion Number:	7. Date:
8. Action:	

cc: User's Group and Lab Staff

Laboratory Problem Report

This form is used to record problems that occur in the SM Computer Labs and what actions were taken to correct them.
Instructions to Users: Please fill in items 1 - 8 below. If more space is needed for Item 8, continue on the back. Lab Staff will complete Items 9 - 12.

5. WHICH LAB ARE YOU IN?	6. WHAT IS THE NUMBER ON THE COMPUTER?
( ) I-158 ( ) I-224 ( ) I-250	

7. WHAT PROGRAM/PROCESS WERE YOU USING WHEN THE PROBLEM OCCURRED?

( ) A_C_O_L ( ) dBase ( ) Email ( ) Emenu ( ) Eprint
( ) F_A_S_M ( ) Lotus 1-2-3 ( ) Mainframe ( ) Scanner ( ) SimPC
( ) Statgraphics ( ) Sys Shutdwn ( ) Sys Startup ( ) WordPerfect
( ) Other_____

8. WILL YOU BRIEFLY DESCRIBE THE PROBLEM (PLEASE GIVE AS MUCH DETAIL AS YOU CAN.)

FOR LAB STAFF USE

1. DATE: / /	2. NAME: 3. FACULTY CODE or SMC#:	4. PHONE:
9. TASK NUMBER (Assigned by Director of Labs):	10. CORRECTED BY:	11. DATE CORRECTED: / /

12. CORRECTIVE ACTION:

Computer Resources Request

Purpose: This form provides a means to request software installation in the PC computer labs, to use the portable computer projector, or other similar type requests.

Procedure: Fill out the first section (General information). Then fill out section A for software installation, section B for use of the portable projector, or section C for other requests. When complete return the request to the "Completed Request" box in room IN-278.

General Information:

Name of requestor: Date:

Telephone: Mail Code or SMC:

Room number or curriculum:

Students - Give instructor/thesis advisor:

Lab desired and date(s) required:

	Mon	Tues	Wed	Thurs	Fri
I-224					
I-250					
I-158					

If the lab is not going to be used on a regular schedule, provide the schedule below:

Dates:

Times:

Have the above times been scheduled through the Department course scheduling process?: Yes / No

Section A (software installation request):

Name of application software:

Version #: Vendor:

Purpose of software installation (check all that apply):

Instruction__ Thesis__ Faculty Research__ Demo__

Course Number (if applicable):

Date Course Starts:

Quarters this course is offered:

Date software required to be operational:

How long do you want the software on the system?:

One quarter__ Indefinitely__ Other__

Computer Type (e.g. AT, Macintosh):

Operating system (Check one): DOS__ Apple__ UNIX__

Operating system version required by program (e.g. DOS 3.2):

How many users will use the software at one time?:

Memory (RAM) requirement in Kilobytes (KB) VERY IMPORTANT:

Hard disk storage required in KB:

Is your software (a stand alone /network) version? (Circle one.)

Do you require print screen capability?: Yes/No

(Note: Print screen capability is not available on the Token Ring network in IN-224.)

Remarks:

Manuals you have: installation__ reference__ user__

Do you need the ceiling mounted projector that displays the instructor's computer screen on the wall screen?: Yes/No

Section B (For use of the portable computer projector):

Where and when will the projector be used:

Note: User must coordinate with the Lab Support Person in IN-354 to pick up projector and necessary cables.

Section C (Other requirements):

Section D (User acceptance):

Date:

I have exercised the installed program and am satisfied that it will perform in a manner that meets my needs.

Requestor's signature:_____

August 30, 1994

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